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(54) **ANTIBODIES FOR USE IN TREATING CONDITIONS RELATED TO SPECIFIC PCSK9 VARIANTS IN SPECIFIC PATIENTS POPULATIONS**

(57) The invention relates to human targets of interest (TOI), anti-TOI ligands, kits compositions and method.

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Description

TECHNICAL FIELD

[0001] The technology described herein relates to ligands, e.g., antibodies for the treatment of disease.

BACKGROUND

[0002] It is recognized that individual humans differ in their sequence and recently several individuals have had their genomes sequenced, for instance James Watson and Craig Venter. Comparison of the genome sequence of individuals has revealed differences in their sequences in both coding and non-coding parts of the genome. Some of these variations in humans are significant and contribute to phenotypic differences between individuals. In extreme cases these will result in genetic disease. The 1000 Genomes Project has the objective of cataloguing sequences in the human genome, involving sequencing the genomes of a very large sampling of individuals from diverse art-recognized human ethnic populations.

[0003] Proprotein convertase subtilisin kexin type 9 (PCSK9) is a serine protease involved in regulating the levels of the low density lipoprotein receptor (LDLR) protein (Horton et al., 2007; Seidah and Prat, 2007). *In vitro* experiments have shown that adding PCSK9 to HepG2 cells lowers the levels of cell surface LDLR (Benjannet et al., 2004; Lagace et al., 2006; Maxwell et al., 2005; Park et al., 2004). Experiments with mice have shown that increasing PCSK9 protein levels decreases levels of LDLR protein in the liver (Benjannet et al., 2004; Lagace et al., 2006; Maxwell et al., 2005; Park et al., 2004), while PCSK9 knockout mice have increased levels of LDLR in the liver (Rashid et al., 2005). Additionally, various human PCSK9 mutations that result in either increased or decreased levels of plasma LDL have been identified (Kotowski et al., 2006; Zhao et al., 2006). PCSK9 has been shown to directly interact with the LDLR protein, be endocytosed along with the LDLR, and co-immunofluoresce with the LDLR throughout the endosomal pathway (Lagace et al., 2006).

[0004] PCSK9 is a prohormone-proprotein convertase in the subtilisin (S8) family of serine proteases (Seidah et al., 2003). Humans have nine prohormone-proprotein convertases that can be divided between the S8A and S8B subfamilies (Rawlings et al., 2006). Furin, PC1/PC3, PC2, PACE4, PC4, PC5/PC6 and PC7/PC8/LPC/SPC7 are classified in subfamily S8B. Crystal and NMR structures of different domains from mouse furin and PC1 reveal subtilisin-like pro- and catalytic domains, and a P domain directly C-terminal to the catalytic domain (Henrich et al., 2003; Tangrea et al., 2002). Based on the amino acid sequence similarity within this subfamily, all seven members are predicted to have similar structures (Henrich et al., 2005). SKI-1/S1P and PCSK9 are classified in subfamily S8A. Sequence comparisons with these proteins also suggest the presence of subtilisin-like pro- and catalytic domains (Sakai et al., 1998; Seidah et al., 2003; Seidah et al., 1999). In these proteins the amino acid sequence C-terminal to the catalytic domain is more variable and does not suggest the presence of a P domain.

[0005] Prohormone-proprotein convertases are expressed as zymogens and they mature through a multi step process. The function of the pro-domain in this process is two-fold. The pro-domain first acts as a chaperone and is required for proper folding of the catalytic domain (Ikemura et al., 1987). Once the catalytic domain is folded, autocatalysis occurs between the pro-domain and catalytic domain. Following this initial cleavage reaction, the pro-domain remains bound to the catalytic domain where it then acts as an inhibitor of catalytic activity (Fu et al., 2000). When conditions are correct, maturation proceeds with a second autocatalytic event at a site within the pro-domain (Anderson et al., 1997). After this second cleavage event occurs the pro-domain and catalytic domain dissociate, giving rise to an active protease.

[0006] Autocatalysis of the PCSK9 zymogen occurs between Gln152 and Ser153 (VFAQ|SIP (SEQ ID NO: 67))(Naureckiene et al., 2003), and has been shown to be required for its secretion from cells (Seidah et al., 2003). A second autocatalytic event at a site within PCSK9's pro-domain has not been observed. Purified PCSK9 is made up of two species that can be separated by non-reducing SDS-PAGE; the pro-domain at 17 Kd, and the catalytic plus C-terminal domains at 65 Kd. PCSK9 has not been isolated without its inhibitory pro-domain, and measurements of PCSK9's catalytic activity have been variable (Naureckiene et al., 2003; Seidah et al., 2003).

[0007] In certain embodiments, a PCSK9 polypeptide includes terminal residues, such as, but not limited to, leader sequence residues, targeting residues, amino terminal methionine residues, lysine residues, tag residues and/or fusion protein residues. "PCSK9" has also been referred to as FH3, NARC1, HCHOLA3, proprotein convertase subtilisin/kexin type 9, and neural apoptosis regulated convertase 1. The PCSK9 gene encodes a proprotein convertase protein that belongs to the proteinase K subfamily of the secretory subtilase family. The term "PCSK9" denotes both the proprotein and the product generated following autocatalysis of the proprotein. When only the autocatalyzed product is being referred to (such as for an antigen binding protein or ligand that binds to the cleaved PCSK9), the protein can be referred to as the "mature," "cleaved", "processed" or "active" PCSK9. When only the inactive form is being referred to, the protein can be referred to as the "inactive", "pro-form", or "unprocessed" form of PCSK9. The term PCSK9 also encompasses PCSK9 molecules incorporating post-translational modifications of the PCSK9 amino acid sequence, such as PCSK9

sequences that have been glycosylated, PCSK9 sequences from which its signal sequence has been cleaved, PCSK9 sequence from which its pro domain has been cleaved from the catalytic domain but not separated from the catalytic domain (see, e.g., FIGS. 1A and 1B of US20120093818A1).

SUMMARY

[0008] Through the application of human genetic variation analysis and rationally-designed sequence selection the present invention provides for improved human patient diagnosis and therapy based on human PCSK9 variation. Importantly, the invention enables tailored medicines that address individual human patient genotypes or phenotypes.

[0009] The inventor's analysis of large numbers of naturally-occurring genomic human PCSK9 sequences reveals that there is significant variation across diverse human populations and provides for the ability for correlation between individual human patients and tailored medical and diagnostic approaches addressing the target. The technical applications of these findings, as per the present invention, thus contribute to better treatment, prophylaxis and diagnosis in humans and provides for patient benefit by enabling personalized medicines and therapies. This provides advantages of better prescribing, less wastage of medications and improved chances of drug efficacy and better diagnosis in patients.

[0010] Furthermore, the inventor surprisingly realised that some rarer natural forms, although present in humans at much lower frequencies than the common form, nevertheless are represented in multiple and ethnically-diverse human populations and usually with many human examples per represented ethnic population. Thus, the inventor realised that targeting such rarer forms would provide for effective treatment, prophylaxis or diagnosis across many human ethnic populations, thereby extending the utility of the present invention and better serving patients in those populations.

[0011] With this, the inventor realised that there is significant industrial and medical application for the invention in terms of guiding the choice of an anti-PCSK9 ligand for administration to human patients for therapy and/or prophylaxis of PCSK9-mediated or associated diseases and conditions. In this way, the patient receives drugs and ligands that are tailored to their needs - as determined by the patient's genetic or phenotypic makeup. Hand-in-hand with this, the invention provides for the genotyping and/or phenotyping of patients in connection with such treatment, thereby allowing a proper match of drug to patient. This increases the chances of medical efficacy, reduces the likelihood of inferior treatment using drugs or ligands that are not matched to the patient (eg, poor efficacy and/or side-effects) and avoids pharmaceutical mis-prescription and waste.

[0012] To this end, the invention provides:-

In a First Configuration

An anti-human PCSK9 ligand for use in a method of treating and/or preventing a PCSK9-mediated disease or condition in a human whose genome comprises a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37, wherein the method comprises administering the ligand to the human.

In a Second Configuration

A ligand that binds a human PCSK9 comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 4-27 for use in a method comprising the step of using the ligand to target said PCSK9 in a human to treat and/or prevent a disease or condition mediated by PCSK9, the method comprising administering the ligand to the human.

In a Third Configuration

A pharmaceutical composition or kit for treating and/or preventing a PCSK9-mediated condition or disease.

In a Fourth Configuration

A method of producing an anti-human PCSK9 antibody binding site, the method comprising obtaining a plurality of anti-PCSK9 antibody binding sites, screening the antibody binding sites for binding to a human PCSK9 selected from the group consisting of forms *f, c, r, p, m, e, h, aj* and *q* or a catalytic or C-terminal domain or a peptide thereof that comprises amino acid variation from the corresponding sequence of SEQ ID NO: 1, 2 or 3 and isolating an antibody binding site that binds in the screening step, and optionally producing a form *f, c, r, p, m, e, h, aj* or *q* PCSK9-binding fragment or derivative of the isolated antibody.

In a Fifth Configuration

A method of producing an anti-human PCSK9 antibody, the method comprising immunising a non-human vertebrate (eg, a mouse or a rat) with a human PCSK9 comprising an amino acid sequence selected from the group consisting of the amino acid sequences of forms *f, c, r, p, m, e, h, aj* and *q* or a catalytic or C-terminal domain or a peptide thereof that comprises amino acid variation from the corresponding sequence of SEQ ID NO: 1, 2 or 3 and isolating an antibody that binds a human PCSK9 comprising selected from the group consisting of forms *f, c, r, p, m, e, h, aj* and *q* or a catalytic or C-terminal domain or a peptide thereof that comprises amino acid variation from the corresponding sequence of SEQ ID NO: 1, 2 or 3, and optionally producing a form *f, c, r, p, m, e, h, aj* or *q* PCSK9-binding fragment or derivative of the isolated antibody.

In a Sixth Configuration

A kit for PCSK9 genotyping a human, wherein the kit comprises a nucleic acid (i) comprising a sequence of contiguous nucleotides that specifically hybridises to a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof, or specifically hybridises to an antisense sequence or an RNA transcript of said sequence, wherein said sequence of contiguous nucleotides hybridises to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridises to an antisense sequence or an RNA transcript thereof; and/or (ii) comprising a sequence of at least 10 contiguous nucleotides of a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or comprising an antisense sequence or RNA version of said contiguous nucleotides, wherein said sequence of contiguous nucleotides comprises at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28.

In a Seventh Configuration

Use of an anti-PCSK9 ligand that binds a human PCSK9 selected from the group consisting of forms *f, c, r, p, m, e, h, aj* and *q* in the manufacture of a medicament for treating and/or preventing a PCSK9-mediated disease or condition in a human whose genome comprises a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37.

In a Eighth Configuration

Use of an anti-PCSK9 ligand that binds a human PCSK9 selected from the group consisting of forms *f, c, r, p, m, e, h, aj* and *q* in the manufacture of a medicament for targeting said PCSK9 in a human to treat and/or prevent a disease or condition mediated by PCSK9.

In a Ninth Configuration

A method of targeting a PCSK9 for treating and/or preventing a PCSK9-mediated disease or condition in a human, the method comprising administering an anti-PCSK9 ligand to a human comprising a nucleotide sequence selected from the group consisting SEQ ID NOs: 29-37, whereby a PCSK9 encoded by said nucleotide sequence is targeted.

In a Tenth Configuration

A method of treating and/or preventing a disease or condition mediated by PCSK9 in a human, the method comprising targeting a human PCSK9 selected from the group consisting of forms *f, c, r, p, m, e, h, aj* and *q* by administering to the human a ligand that binds said PCSK9 thereby treating and/or preventing said disease or condition in the human.

In a Eleventh Configuration

A method of PCSK9 genotyping a nucleic acid sample of a human, the method comprising identifying in the sample the presence of a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or the catalytic- or C-terminal domain-encoding sequence thereof.

In a Twelfth Configuration

A method of PCSK9 typing a protein sample of a human, the method comprising identifying in the sample the presence of a human PCSK9 selected from the group consisting of forms *f, c, r, p, m, e, h, aj* and *q.*

In a Thirteenth Configuration

A method of treating and/or preventing in a human patient a cardiovascular disease or condition, or a disease or condition that is associated with elevated LDL cholesterol (eg, hypercholesterolaemia), wherein the patient is receiving or has previously received statin treatment for said disease or condition, the method comprising typing the patient using a method of the invention and administering a ligand according to the invention whereby the human is treated or said disease or condition is prevented; optionally also reducing or stopping statin treatment.

In a Fourteenth Configuration

An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody or fragment comprises a human gamma-1 heavy chain constant region that comprises an Asp corresponding to position 204 of SEQ ID NO: 42 or a Leu corresponding to position 206 of SEQ ID NO: 42, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation I474V or E670G in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said amino acid sequence and comprises an IGHG1*01 human heavy chain constant region gene segment, or the human expresses antibodies comprising human gamma-1 constant regions comprising such an Asp and Leu.

In a Fifteenth Configuration

A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 or E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human gamma-1 heavy chain constant region that comprises an Asp corresponding to position 204 of SEQ ID NO: 42 or a Leu corresponding to position 206 of SEQ ID NO: 42 and wherein said human comprises (i) an IGHG1*01 human heavy chain constant region gene segment, or the human expresses antibodies comprising human gamma-1 heavy chain constant regions

comprising such an Asp and Leu and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1.

In a Sixteenth Configuration

An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody comprises a human gamma-2 heavy chain constant region that comprises an amino acid selected from the group consisting of a Pro corresponding to position 72 of SEQ ID NO: 44, an Asn corresponding to position 75 of SEQ ID NO: 44, a Phe corresponding to position 76 of SEQ ID NO: 44, a Val corresponding to position 161 of SEQ ID NO: 44 and an Ala corresponding to position 257 of SEQ ID NO: 44, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation I474V or E670G in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said amino acid sequence and comprises an IGHG2*01 human heavy chain constant region gene segment, or the human expresses antibodies comprising human gamma-2 constant regions comprising such a Pro, Asn, Phe, Val and Ala.

In a Seventeenth Configuration

A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 or E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human gamma-2 heavy chain constant region that comprises an amino acid selected from the group consisting of a Pro corresponding to position 72 of SEQ ID NO: 44, an Asn corresponding to position 75 of SEQ ID NO: 44, a Phe corresponding to position 76 of SEQ ID NO: 44, a Val corresponding to position 161 of SEQ ID NO: 44 and an Ala corresponding to position 257 of SEQ ID NO: 44 and wherein said human comprises (i) an IGHG2*01 human heavy chain constant region gene segment, or the human expresses antibodies comprising human gamma-2 heavy chain constant regions comprising such a Pro, Asn, Phe, Val and Ala and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1.

In a Eighteenth Configuration

An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody or fragment comprises a human kappa light chain constant region that comprises a Val corresponding to position 84 of SEQ ID NO: 50 or a Cys corresponding to position 87 of SEQ ID NO: 50, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation I474V or E670G in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said amino acid sequence and comprises an IGKC*01 human light chain constant region gene segment, or the human expresses antibodies comprising human kappa light chain constant regions comprising such an Val and Cys.

In a Nineteenth Configuration

A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 or E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human kappa light chain constant region that comprises a Val corresponding to position 84 of SEQ ID NO: 50 or a Cys corresponding to position 87 of SEQ ID NO: 50 and wherein said human comprises (i) an IGKC*01 human light chain constant region gene segment, or the human expresses antibodies comprising human kappa light chain constant regions comprising such an Val and Cys and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1.

In a Twentieth Configuration

An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody or fragment comprises a human IGLC2*01 lambda light chain constant region, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation I474V or E670G in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said amino acid sequence and comprises a human IGLC2*01 lambda light chain constant region gene segment, or the human expresses antibodies comprising human IGLC2*01 lambda light chain constant regions.

In a Twenty-First Configuration

A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 or E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human IGLC2*01 lambda light chain constant region and wherein said human comprises (i) an IGLC2*01 human light chain constant region gene segment,

or the human expresses antibodies comprising a human IGLC2*01 lambda light chain constant regions and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1.

In a Twenty-Second Configuration

An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody or fragment comprises a human variable domain that is derived from the recombination of a human VH gene segment, a human D gene segment and a human JH gene segment, wherein the VH gene segment is derived from the recombination of a human VH gene segment, a human D gene segment and a human JH gene segment, wherein the VH gene segment is selected from the group consisting of (i) IGHV1-18*01 and the genome of the human comprises a human IGHV1-18*01 nucleotide sequence or the human expresses antibodies comprising variable domains derived from the recombination of human IGHV1-18*01; or (ii) IGVH1-46*01 and the genome of the human comprises a human IGHV1-46*01 nucleotide sequence or the human expresses antibodies comprising variable domains derived from the recombination of human IGHV1-46*01, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation I474V or E670G in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said amino acid sequence, and comprises said VH gene segment or expresses antibodies comprising VH domains that are derived from the recombination of said human VH gene segment, a human D gene segment and a human JH gene segment.

In a Twenty-Third Configuration

A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 or E670G in SEQ ID NO: 1, wherein (i) the antibody or fragment comprises a human variable domain that is derived from the recombination of a human VH gene segment, a human D gene segment and a human JH gene segment, wherein the VH gene segment is selected from the group consisting of (a) IGHV1-18*01 and the genome of the human comprises a human IGHV1-18*01 nucleotide sequence or the human expresses antibodies comprising variable domains derived from the recombination of human IGHV1-18*01; and (b) IGVH1-46*01 and the genome of the human comprises a human IGHV1-46*01 nucleotide sequence or the human expresses antibodies comprising variable domains derived from the recombination of human IGHV1-46*01, and wherein said human comprises (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1.

In a Twenty-Fourth Configuration

A method for treating a PCSK9-mediated disease or condition in a human by targeting a PCSK9 that comprises a C-terminal domain amino acid polymorphism (compared to SEQ ID NO: 1), the method comprising administering to the human a ligand (eg, an antibody or fragment) that has been determined to specifically bind to a PCSK9 comprising a C-terminal domain comprising I474V or 670G (numbering according to SEQ ID NO:1); wherein the human expresses said PCSK9 or the genome of the human comprises a nucleotide sequence encoding said PCSK9; wherein said human is treated for said disease or condition.

In a Twenty-Fifth Configuration

A method of reducing cholesterol level or maintaining a previously reduced cholesterol level in a human in need thereof, the method comprising:-

a. Carrying out an initial treatment of said human for an initial treatment period by administering an anti-human PCSK9 ligand (eg, an antibody or fragment) to said human, wherein (i) the ligand has been determined to specifically bind to a PCSK9 comprising a C-terminal domain comprising I474V or 670G (numbering according to SEQ ID NO:1); (ii) the human expresses said PCSK9 or the genome of the human comprises a nucleotide sequence encoding said PCSK9 and (iii) the human has received or is receiving statin treatment to lower or maintain cholesterol level; wherein the initial treatment comprises the administration of a single or multiple doses of the ligand to the human;

b. Determining to (i) terminate statin treatment (ii) keep the human off statin treatment; or (iii) reduce statin treatment after said initial treatment period; and

c. Continuing to administer the ligand to said patient after said time period has expired, thereby reducing cholesterol level or maintaining a previously reduced cholesterol level in said human.

In a Twenty-Sixth Configuration

An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody or fragment comprises a human (eg, gamma) heavy chain constant region that comprises a first amino acid that is encoded by a human (eg, gamma) heavy chain

constant region gene segment SNP, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation I474V or E670G in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said PCSK9 amino acid sequence and comprises a human (eg, gamma) heavy chain constant region gene segment comprising said SNP, or the human expresses antibodies comprising human (eg, gamma) constant regions comprising said first amino acid.

In a Twenty-Seventh Configuration

An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody or fragment comprises a human (eg, kappa or lambda) light chain constant region that comprises a first amino acid that is encoded by a human (eg. kappa or lambda respectively) light chain constant region gene segment SNP, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation I474V or E670G in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said PCSK9 amino acid sequence and comprises a human (eg, kappa or lambda respectively) light chain constant region gene segment comprising said SNP, or the human expresses antibodies comprising human (eg, kappa or lambda respectively) constant regions comprising said first amino acid.

In a Twenty-Eighth Configuration

An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody or fragment comprises a human variable (eg, VH, Vκ or Vλ) domain that comprises a first amino acid that is encoded by a V (eg, VH, Vκ or Vλ respectively) gene segment SNP, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation I474V or E670G in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said PCSK9 amino acid sequence and comprises a human V (eg, VH, Vκ or Vλ respectively) gene segment comprising said SNP, or the human expresses antibodies comprising V (eg, VH, Vκ or Vλ respectively) domains comprising said first amino acid.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Figure 1 shows *in silico* modeling of PCSK9 surface variant residues.

Figure 2 depicts the cumulative allele frequency distribution across the 1000 Genomes Project databse of human VH3-23 alleles comprising SNP rs56069819 (such alleles denonted "C" and the most frequent allele (which does not comprise this SNP) denoted "A").

Figure 3 depicts frameworks and CDRs encoded by VH3-23*04 as obtained from the IMGT database (available on the World Wide Web at www.IMGT.org). Figure 3 discloses the nucleotide sequences as SEQ ID NOS 69, 69, 69, 71, 71, 71, 72, 74, 76, 39 and 77, respectively, in order of appearance. Figure 3 discloses the coded amino acid sequences as SEQ ID NOS 70, 70, 70, 70, 70, 70, 73, 75, 75, 38 and 78, respectively, in order of appearance.

Figure 4 depicts sequences of VH3-23*04. The portion of VH3-23*04 comprising the FW1 residue change of rs56069819 (SEQ ID NO: 38). The portion of the nucleic acid sequence encoding rs56069819 is depicted (SEQ ID NO: 39). The FW1 encoded by VH3-23*04 is depicted (SEQ ID NO: 40).

DETAILED DESCRIPTION

[0014] The skilled person will know that SNPs or other changes that translate into amino acid variation can cause variability in conformation or activity of human targets to be addressed. This has spawned great interest in personalized medicine where genotyping and knowledge of protein and nucleotide variability is used to tailor medicines and diagnosis of patients more effectively. The present invention provides for tailored pharmaceuticals and testing that specifically addresses rarer variant forms of a human target of interest (TOI), that target being human PCSK9.

[0015] The present invention harnesses the power of human genetic variation analysis and rationally-designed sequence selection. The technical applications of these approaches, as per the present invention, contribute to better treatment, prophylaxis and diagnosis in humans and provides for patient benefit by providing choice and enabling personalized medicines and therapies. This provides advantages of better prescribing, less wastage of medications and improved chances of drug efficacy and better diagnosis in patients.

[0016] As sources of genomic sequence variation data, the skilled person will be aware of the available databases and resources (including updates thereof) provided by the following:-

1. HapMap (The International HapMap Consortium. 2003; http://hapmap.ncbi.nlm.nih.gov/index.html.en). The HapMap Project is an international project that aims to compare the genetic sequences of different individuals to identify

chromosomal regions containing shared genetic variants. The HapMap www site provides tools to identify chromosomal regions and the variant therein, with options to drill down to population level frequency data.
2. 1000 Genomes Project (The 1000 Genomes Project Consortium 2010; available on the World Wide Web at http://www.1000genomes.org/). This resource provides complete genomic sequence for at least 2500 unidentified individuals from one of 25 distinct population groups.
3. Japanese SNP Database(H.Haga et al. 2002; available on the World Wide Web at http://snp.ims.u-tokyo.ac.jp/index.html). Based on a study identifying 190,562 human genetic variants.

[0017] The present invention involves the identification and cataloguing of naturally-occurring human genomic target sequence variants, including those found to be relatively low-frequency or rare variants that segregate with specific human ethnic populations and in many individual humans.
[0018] An aspect of the invention is based on rational design of sequence selection addressing the desirability to tailor medicaments and diagnostics to rarer, but yet still significant groups of human individuals that suffer from, or have the potential to suffer from (ie, who are at risk of), a disease or condition mediated or associated with the target of interest. In devising this rational design of the present aspect of the invention, the inventor included considerations of the spread of prevalence of naturally-occurring target variant sequences across multiple, diverse human ethnic populations, as well as the importance of addressing such populations where many individuals are likely to display a genotype and/or phenotype of one or more of the variants being analysed. As part of this design, the inventor saw the importance of adopting the art-recognised classifications of human ethnic populations, and in this respect the inventor based the analysis and design on the recognised human ethnic populations adopted by the 1000 Genomes Project, since this is a resource that is, and will continue to be, widely adopted by the scientific and medical community.
[0019] Figure 2 shows the cumulative allele frequency distribution across the 1000 Genomes Project databse of human VH3-23 alleles comprising SNP rs56069819 (such alleles denonted "C" and the most frequent allele (which does not comprise this SNP) denoted "A"). The figure shows that VH3-23 alleles comprising SNP rs56069819 are present at a cumulative frequency of 11% across all human ethnic populations taken as a whole, whereas in certain specific human ethnic sub-populations (ASW, LWK, YRI, CEU and GBR) such alleles are present at an above-average cumulative frequency. Indicated in the figure are those human PCSK9 variant forms (marked "Variants") that are found in the various sub-populations with above-average occurrence of human VH3-23 alleles comprising SNP rs56069819.
[0020] Thus, in this aspect of the invention, the inventor designed the following variant sequence selection criteria, these being criteria that the inventor realised would provide for useful medical drugs and diagnostics to tailored need in the human population.

Selection Criteria

[0021] Three or four of the following:-

- Naturally-occurring human PCSK9 variant sequences having a cumulative human allele frequency of 35% or less;
- Naturally-occurring human PCSK9 variant sequences having a total human genotype frequency of 40% or less;
- Naturally-occurring human PCSK9 variant sequences found in many different human ethnic populations (using the standard categorisation of the 1000 Genomes Project; see Table 4 below); and
- Naturally-occurring human PCSK9 variant sequences found in many individuals distributed across such many different ethnic populations.

[0022] The inventor's selection included, as a consideration, selection for nucleotide variation that produced amino acid variation in corresponding PCSK9 forms (ie, non-synonymous variations), as opposed to silent variations that do not alter amino acid residues in the target protein.
[0023] Optionally, further sequence analysis and 3D *in silico* modelling (eg, see Figure 1) can also be used as an additional selection criterion: variants whose variant amino acid residues (versus the most common form of human PCSK9) are surface-exposed on the target are desirable for selection, since the inventor saw these as contributing to determining the topography of the target and potentially contributing to how and where ligand binding on the target occurs.
[0024] In an embodiment, the cumulative human allele frequency is 30, 25, 20, 15, 10 or 5% or less, eg, in the range from 1 to 20% or 1 to 15% or 1 to 10%.
[0025] In an embodiment, the total human genotype frequency is 35, 30, 25, 20, 15, 10 or 5% or less, eg, in the range from 1 to 25%, 1 to 20%, 1 to 15%, 1 to about 15%, 1 to 10%, 1 to about 10% or 1 to 5% or 1 to about 5%.
[0026] In an embodiment, the naturally-occurring human target variant sequences are found in at least 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19 or 20 different human ethnic populations (using the standard categorisation of the 1000 Genomes Project).
[0027] In an embodiment, the naturally-occurring human target variant sequences are found in at least 20, 25, 30, 35,

40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 105, 110, 115, 120, 130, 140 or 150 individuals distributed across such many different ethnic populations.

[0028] In an example, the following criteria are applied:-

- Naturally-occurring human PCSK9 variant sequences having a cumulative human allele frequency of 15% or less;
- Naturally-occurring human PCSK9 variant sequences having a total human genotype frequency of 20% or less;
- Naturally-occurring human PCSK9 variant sequences found in at least 5 different human ethnic populations (using the standard categorisation of the 1000 Genomes Project); and
- Naturally-occurring human PCSK9 variant sequences found in many individuals distributed across such many different ethnic populations.

[0029] In any aspect, configuration, example, embodiment, clause or concept herein, frequencies may be determined using bioinformatics.

[0030] In any aspect, configuration, example, embodiment, clause or concept herein, frequencies may be determined by reference to a database comprising at least 1000 or 2000 human sequences.

[0031] In any aspect, configuration, example, embodiment, clause or concept herein "heterozygous human genotype frequency" means the cumulative frequency of all genotypes in the sample or database or in humans having one occurrence of the rare variant allele and one occurrence of another allele (heterozygous state), eg, genotype in 1000 Genomes database.

[0032] In any aspect, configuration, example, embodiment, clause or concept herein "homozygous human genotype frequency means the cumulative frequency of two occurrences of the variant allele (homozygous state), eg, genotype in 1000 Genomes Project database.

[0033] In any aspect, configuration, example, embodiment, clause or concept herein "total human genotype frequency" means the total of heterozygous plus homozygous human genotype frequencies.

[0034] In any aspect, configuration, example, embodiment, clause or concept herein "cumulative human allele frequency" refers to the total of all occurrences of the variant allele in the sample or database or in humans, eg, in the 1000 Genomes Project database.

[0035] In an example, the criteria are applied with reference to one or more human genomic sequence databases as described herein. For example, the criteria are those as applied to the 1000 Genomes database.

[0036] For example in any aspect example, embodiment or configuration of the invention, the 1000 Genomes database release 13. For example, the 1000 Genomes database in its most recent version as at 1 October 2013.

[0037] The following bioinformatics protocol is envisaged to indentify human sequences for use in the present invention:

(a) Identify a genomic region containing a PCSK9 target sequence of interest ('target genomic region') and calculate the genomic coordinates, using coordinates that match the sequence assembly build used by either the 1000 Genomes Project or International HapMap project (or another selected human gene database of choice).

(b) Identify genomic variants mapped to the genomic region previously identified in (a). Retrieve allele frequencies for variants for each super population and preferably subpopulation where such data is available. The VWC tools for the 1000 Genomes Project can be used for this step.

(c) Filter list of genomic variants from target genomic region to contain only variants classed as either 'non-synonymous' single nucleotide polymorphisms (SNPs) or genomic 'insertions or delections' (indels). Filter further to include those that are present in exonic sequences only. "Non-synonymous" refers to nucleotide variation that produces amino acid variation (ie, excluding silent mutations).

(d) Correlate population frequency data for each of the identified variants for each of the super populations (for example 'European Ancestry', 'East Asian ancestry', 'West African ancestry', 'Americas', and 'South Asian ancestry') to identify those variants that segregate with less than two super-populations. Further correlate all identified variants with each of the sub-populations (for example, 'European ancestry' super-population might be subdivided into groups such as 'CEU - Utah residents with Northern or Western European ancestry', 'TSI Toscani in Italia' and 'British from England and Scotland') and produce a second score for rarity of variants within a super-population.

(e) Collect one or more sequences that show segregation to specific sub-populations for use in the present invention, eg, according to selection criteria as described herein.

Human Populations

[0038] Optionally the ethnic populations are selected from those identified in the 1000 Genomes Project database. In this respect, see Table 4 which provides details of the ethnic populations on which the 1000 Genomes Project database is based.

[0039] N A Rosenberg eta/(Science 20 December 2002: vol. 298 no. 5602 2342-2343) studied the genetic structure

of human populations of differing geographical ancestry. In total, 52 populations were sampled, these being populations with:

African ancestry
(Mbuti Pygmies, Biaka Pygmies, San peoples, and speakers of Niger-Kordofanian languages (Bantu, Yoruba or Mandenka populations),
Eurasian ancestry

(European ancestry (Orcadian, Adygel, Basque, French, Russians, Italians, Sardinian, Tuscan), Middle Eastern ancestry (Mozabite, Bedouin, Druze, Palestinians),
Central/South Asian ancestry (Balochl, Brahul, Makrani, Sindhi, Pathan, Burusho, Hazara, Uygur, Kalash)),

East Asian ancestry
(Han, Dal, Daur, Hezhen, Lahu, Miao, Oroqen, She, Tujia, Tu, Xibo, Yi, Mongola, Naxi, Cambodian, Japanese, Yakut), Oceanic ancestry (Melanesian, Papuan); or
Americas ancestry
(Karitiana, Surui, Colombian, Maya, Pima).

[0040] The International HapMap Project, Nature, 2003 Dec 18;426(6968):789-96, discloses that goal of the HapMap Project: to determine the common patterns of DNA sequence variation in the human genome by determining the genotypes of one million or more sequence variants, their frequencies and the degree of association between them in DNA samples from populations with ancestry from parts of Africa, Asia and Europe. The relevant human populations of differing geographical ancestry include Yoruba, Japanese, Chinese, Northern European and Western European populations. More specifically:-

Utah population with Northern or Western European ancestry (samples collected in 1980 by the Centre d'Etude du Polymorphisme Humain (CEPH));
population with ancestry of Yoruba people from Ibadan, Nigeria;
population with Japanese ancestry; and
population with ancestry of Han Chinese from China.

[0041] The authors, citing earlier publications, suggest that ancestral geography is a reasonable basis for sampling human populations.
[0042] A suitable sample of human populations used in the present invention is as follows:-

(a) *European ancestry*
(b) Northern European ancestry; Western European ancestry; Toscani ancestry; British ancestry, Finnish ancestry or Iberian ancestry.
(c) More specifically, population of Utah residents with Northern and/or Western European ancestry; Toscani population in Italia; British population in England and/or Scotland; Finnish population in Finland; or Iberian population in Spain.
(a) *East Asian ancestry*
(b) Japanese ancestry; Chinese ancestry or Vietnamese ancestry.
(c) More specifically, Japanese population in Toyko, Japan; Han Chinese population in Beijing, China; Chinese Dai population in Xishuangbanna; Kinh population in Ho Chi Minh City, Vietnam; or Chinese population in Denver, Colorado, USA.
(a) *West African ancestry*
(b) Yoruba ancestry; Luhya ancestry; Gambian ancestry; or Malawian ancestry.
(c) More specifically, Yoruba population in Ibadan, Nigeria; Luhya population in Webuye, Kenya; Gambian population in Western Division, The Gambia; or Malawian population in Blantyre, Malawi.
(a) Population of The Americas
(b) Native American ancestry; Afro-Caribbean ancestry; Mexican ancestry; Puerto Rican ancestry; Columbian ancestry; or Peruvian ancestry.
(c) More specifically, population of African Ancestry in Southwest US; population of African American in Jackson, MS; population of African Caribbean in Barbados; population of Mexican Ancestry in Los Angeles, CA; population of Puerto Rican in Puerto Rico; population of Colombian in Medellin, Colombia; or population of Peruvian in Lima, Peru.
(a) South Asian ancestry

(b) Ahom ancestry; Kayadtha ancestry; Reddy ancestry; Maratha; or Punjabi ancestry.
(c) More specifically, Ahom population in the State of Assam, India; Kayadtha population in Calcutta, India; Reddy population in Hyderabad, India; Maratha population in Bombay, India; or Punjabi population in Lahore, Pakistan.

[0043] In any configuration of the invention, in one embodiment, each human population is selected from a population marked "(a)" above.
[0044] In any configuration of the invention, in another embodiment, each human population is selected from a population marked "(b)" above.
[0045] In any configuration of the invention, in another embodiment, each human population is selected from a population marked "(c)" above.
[0046] In one embodiment the ethnic populations are selected from the group consisting of an ethnic population with European ancestry, an ethnic population with East Asian, an ethnic population with West African ancestry, an ethnic population with Americas ancestry and an ethnic population with South Asian ancestry.
[0047] In one embodiment the ethnic populations are selected from the group consisting of an ethnic population with Northern European ancestry; or an ethnic population with Western European ancestry; or an ethnic population with Toscani ancestry; or an ethnic population with British ancestry; or an ethnic population with Icelandic ancestry; or an ethnic population with Finnish ancestry; or an ethnic population with Iberian ancestry; or an ethnic population with Japanese ancestry; or an ethnic population with Chinese ancestry; or an ethnic population Vietnamese ancestry; or an ethnic population with Yoruba ancestry; or an ethnic population with Luhya ancestry; or an ethnic population with Gambian ancestry; or an ethnic population with Malawian ancestry; or an ethnic population with Native American ancestry; or an ethnic population with Afro-Caribbean ancestry; or an ethnic population with Mexican ancestry; or an ethnic population with Puerto Rican ancestry; or an ethnic population with Columbian ancestry; or an ethnic population with Peruvian ancestry; or an ethnic population with Ahom ancestry; or an ethnic population with Kayadtha ancestry; or an ethnic population with Reddy ancestry; or an ethnic population with Maratha; or an ethnic population with Punjabi ancestry.

Anti-Target Ligands

[0048] The invention provides useful anti-target ligands for addressing humans suffering from or likely to suffer from a disease or condition mediated or associated with PCSK9. For example, the ligand specifically binds to a PCSK9 variant as per the invention. The ligand may inhibit or antagonise the activity of the PCSK9 target, eg, the ligand neutralises the target. The skilled person will be familiar with neutralising ligands in general, such as antibodies or antibody fragments, and can readily test suitable ligands for specific binding and/or neutralisation of a target *in vitro or* in an *in vivo* assay.
[0049] In an example, the ligand is (or has been determined as) a neutraliser of the PCSK9. In an example, determination is carried out in a human (eg, in a clinical trial). In an example, determination is carried out in a non-human, eg, in a mouse, rat, rabbit, pig, dog, sheep or non-human primate (eg, Cynomolgous monkey, rhesus monkey or baboon).
[0050] An antibody "fragment" comprises a portion of an intact antibody, preferably the antigen binding and/or the variable region of the intact antibody. Examples of antibody fragments include dAb, Fab, Fab', F(ab')2 and Fv fragments; diabodies; linear antibodies; single-chain antibody molecules and multispecific antibodies formed from antibody fragments.
[0051] In an embodiment, the ligand of the invention is or comprises an antibody or antibody fragment, for example an antibody or fragment comprising human variable regions (and optionally also human constant regions). Anti-PCSK9 or PCSK9-binding or targeting antibodies and fragments can be prepared according to any known method, eg, using transgenic mice (eg, the Kymouse™ or Velocimouse™, or Omnimouse™ , Xenomouse™, HuMab Mouse™ or MeMo Mouse™), rats (eg, the Omnirat™), camelids, sharks, rabbits, chickens or other non-human animals immunised with the PCSK9 followed optionally by humanisation of the constant regions and/or variable regions to produce human or humanised antibodies. In an example, display technologies can be used, such as yeast, phage or ribosome display, as will be apparent to the skilled person. Standard affinity maturation, eg, using a display technology, can be performed in a further step after isolation of an antibody lead from a transgenic animal, phage display library or other library. Representative examples of suitable technologies are described in US20120093818 (Amgen, Inc), which is incorporated by reference herein in its entirety, eg, the methods set out in paragraphs [0309] to [0346].
[0052] Generally, a VELOCIMMUNE™ or other mouse or rat can be challenged with the antigen of interest, and lymphatic cells (such as B-cells) are recovered from the mice that express antibodies. The lymphatic cells may be fused with a myeloma cell line to prepare immortal hybridoma cell lines, and such hybridoma cell lines are screened and selected to identify hybridoma cell lines that produce antibodies specific to the antigen of interest. DNA encoding the variable regions of the heavy chain and light chain may be isolated and linked to desirable isotypic constant regions of the heavy chain and light chain. Such an antibody protein may be produced in a cell, such as a CHO cell. Alternatively, DNA encoding the antigen-specific chimaeric antibodies or the variable domains of the light and heavy chains may be isolated directly from antigen-specific lymphocytes.

[0053] Initially, high affinity chimaeric antibodies are isolated having a human variable region and a mouse constant region. As described below, the antibodies are characterized and selected for desirable characteristics, including affinity, selectivity, epitope, etc. The mouse constant regions are replaced with a desired human constant region to generate the fully human antibody of the invention, for example wild-type or modified IgG1 or IgG4 (for example, SEQ ID NO: 751, 752,753 in US2011/0065902 (which is incorporated by reference herein in its entirety), which sequences are incorporated herein by reference for use in the ligands of the present invention). While the constant region selected may vary according to specific use, high affinity antigen-binding and target specificity characteristics reside in the variable region.

[0054] In an example, the ligand of the invention is or comprises a nucleic acid, eg, RNA, eg, siRNA that hybridises under stringent condition to the PCSK9 variant sequence, eg, hybridises a nucleotide sequence comprising one or more nucleotides that are variant (versus the most common PCSK9 sequence, eg, with reference to the 1000 Genomes Project database).

[0055] For example, the nucleic acid hybridises to a region immediately flanking a nucleotide that is variant compared to the corresponding nucleotide of the PCSK9 nucleotide sequence having the highest cumulative human allele frequency and/or the highest total human genotype frequency. In an example, the nucleic acid hybridises to at two or more such variant nucleotides.

[0056] Specific hybridisation is under stringent conditions, as will be apparent to the skilled person, eg, conditions of 5×SSC, 5×Denhardt's reagent, and 0.5% SDS at 65° C.

[0057] Target binding ability, specificity and affinity (Kd, K_{off} and/or K_{on}) can be determined by any routine method in the art, eg, by surface plasmon resonance (SPR). The term "Kd", as used herein, is intended to refer to the equilibrium dissociation constant of a particular antibody-antigen interaction.

[0058] In one embodiment, the surface plasmon resonance (SPR) is carried out at 25°C. In another embodiment, the SPR is carried out at 37°C.

[0059] In one embodiment, the SPR is carried out at physiological pH, such as about pH7 or at pH7.6 (eg, using Hepes buffered saline at pH7.6 (also referred to as HBS-EP)).

[0060] In one embodiment, the SPR is carried out at a physiological salt level, eg, 150mM NaCl.

[0061] In one embodiment, the SPR is carried out at a detergent level of no greater than 0.05% by volume, eg, in the presence of P20 (polysorbate 20; eg, Tween-20™) at 0.05% and EDTA at 3mM.

[0062] In one example, the SPR is carried out at 25°C or 37°C in a buffer at pH7.6, 150mM NaCl, 0.05% detergent (eg, P20) and 3mM EDTA. The buffer can contain 10mM Hepes. In one example, the SPR is carried out at 25°C or 37°C in HBS-EP. HBS-EP is available from Teknova Inc (California; catalogue number H8022).

[0063] In an example, the affinity of the ligand (eg, antibody) is determined using SPR by

1. Coupling anti-mouse (or other relevant human, rat or non-human vertebrate antibody constant region species-matched) IgG (eg, Biacore™ BR-1008-38) to a biosensor chip (eg, GLM chip) such as by primary amine coupling;
2. Exposing the anti-mouse IgG (or other matched species antibody) to a test IgG antibody to capture test antibody on the chip;
3. Passing the test antigen over the chip's capture surface at 1024nM, 256nM, 64nM, 16nM, 4nM with a 0nM (i.e. buffer alone); and
4. And determining the affinity of binding of test antibody to test antigen using surface plasmon resonance, eg, under an SPR condition discussed above (eg, at 25°C in physiological buffer). SPR can be carried out using any standard SPR apparatus, such as by Biacore™ or using the ProteOn XPR36™ (Bio-Rad®).

[0064] Regeneration of the capture surface can be carried out with 10mM glycine at pH1.7. This removes the captured antibody and allows the surface to be used for another interaction. The binding data can be fitted to 1:1 model inherent using standard techniques, eg, using a model inherent to the ProteOn XPR36™ analysis software.

[0065] In an example, the ligand of the invention is contained in a medical container, eg, a vial, syringe, IV container or an injection device (eg, an intraocular or intravitreal injection device). In an example, the ligand is *in vitro,* eg, in a sterile container. In an example, the invention provides a kit comprising the ligand of the invention, packaging and instructions for use in treating or preventing or diagnosing in a human a disease or condition mediated by the PCSK9. In an example, the instructions indicate that the human should be genotyped for a PCSK9 variant sequence of the invention before administering the ligand to the human. In an example, the instructions indicate that the human should be phenotyped for a PCSK9 variant of the invention before administering the ligand to the human. In an example, the human is of Chinese (eg, Han or CHS) ethnicity and the instructions are in Chinese (eg, Mandarin). In an example, the instructions comprise directions to administer alirocumab or evolocumab to said human.

[0066] The invention addresses the need to treat humans having naturally-occurring rarer natural PCSK9 alleles, genotypes and phenotypes (rarer protein forms). In this respect, the invention provides the following aspects.

[0067] **In a First Aspect:** An anti-human PCSK9 ligand for use in a method of treating and/or preventing a PCSK9-

mediated disease or condition in a human whose genome comprises a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37, wherein the method comprises administering the ligand to the human.

[0068] In an example, the nucleotide sequence is selected from the group consisting of SEQ ID NOs: 29-35 and 37; or selected from the group consisting of SEQ ID NOs: 29-32 and 34-37; or selected from the group consisting of SEQ ID NOs: 29-32, 34, 35 and 37. These are naturally-occurring allele (haplotype) sequences that do not encode 46L and which meet the criteria set out above. These groups comprise variants that are associated with elevated LDL-C.

[0069] In an example, the nucleotide sequence is SEQ ID NO: 34, that encodes a 425S, which is associated with elevated LDL-C (Pisciotta *et al* 2006).

[0070] In an example, the nucleotide sequence selected from the group consisting of SEQ ID NOs: 31 and 37, that encode 670G which is a marker for severity of coronary atherosclerosis (Chen *et al* 2005).

[0071] In an example, the nucleotide sequence selected from the group consisting of SEQ ID NOs: 31, 32, 34, 35, 36 and 37; or selected from the group consisting of SEQ ID NOs: 31, 32, 34, 35 and 37. These are allele (haplotype) sequences that have a naturally-occurring combination of differences from SEQ ID NO: 28 (form *a*) and which meet the criteria set out above.

[0072] In an example, the nucleotide sequence is SEQ ID NO: 29.

[0073] In an example, the nucleotide sequence is SEQ ID NO: 30.

[0074] In an example, the nucleotide sequence is SEQ ID NO: 31.

[0075] In an example, the nucleotide sequence is SEQ ID NO: 32.

[0076] In an example, the nucleotide sequence is SEQ ID NO: 33.

[0077] In an example, the nucleotide sequence is SEQ ID NO: 34.

[0078] In an example, the nucleotide sequence is SEQ ID NO: 35.

[0079] In an example, the nucleotide sequence is SEQ ID NO: 36.

[0080] In an example, the nucleotide sequence is SEQ ID NO: 37.

[0081] The PCSK9 variant is not the most frequent.

[0082] In an embodiment of any configuration, example, embodiment or aspect herein, the ligand, antibody, fragment or binding site of the invention is recombinant.

[0083] **In a Second Aspect:** The ligand of aspect 1, wherein the ligand has been or is determined as capable of binding a human PCSK9 selected from the group consisting forms *f, c*, *r, p, m, e, h, aj* and *q.*

[0084] In an example of any aspect, the ligand binds (or has been determined to bind) two, three, four or more human PCSK9 selected from the group consisting forms *f, c, r, p, m, e, h, aj and q.*

[0085] In an example of any aspect, the ligand comprises a protein domain that specifically binds to PCSK9, eg, a human PCSK9 selected from the group consisting forms *f, c, r, p, m, e, h, aj* and *q.*

[0086] The term "specifically binds," or the like, means that a ligand, eg, an antibody or antigen-binding fragment thereof, forms a complex with an antigen that is relatively stable under physiologic conditions. Specific binding can be characterized by an equilibrium dissociation constant of at least about 1×10^{-6} M or less (e.g., a smaller KD denotes a tighter binding). Methods for determining whether two molecules specifically bind are well known in the art and include, for example, equilibrium dialysis, surface plasmon resonance, and the like. An isolated antibody that specifically binds a human PCSK9 may, however, exhibit cross-reactivity to other antigens such as a PCSK9 molecule from another species. Moreover, multi-specific antibodies (e.g., bispecifics) that bind to human PCSK9 and one or more additional antigens are nonetheless considered antibodies that "specifically bind" PCSK9, as used herein.

[0087] In an example of any aspect, the ligand comprises or consists of a protein that mimics the EGFA domain of the LDL receptor and specifically binds to PCSK9, eg, a human PCSK9 selected from the group consisting forms *f, c, r, p, m, e, h, aj* and *q.*

[0088] In an example of any aspect, the ligand antagonises PCSK9, eg, a human PCSK9 selected from the group consisting forms *f, c, r, p, m, e, h, aj* and *q.*

[0089] In an example of any aspect, the method comprises (before administering the ligand) the step of determining that the ligand is capable of binding a human PCSK9 selected from the group consisting forms *f, c, r, p, m, e, h, aj* and *q.*

[0090] In an example of any aspect, binding is determined by SPR. In an example of any aspect, binding is determined by ELISA.

[0091] In an example of any aspect, said forms are the mature forms.

[0092] In an example of any aspect, said forms are the pro-forms.

[0093] The terms "is determined", "is genotyped" or "is phenotyped" and the like herein mean that the method comprises a step of such determining, genotyping or phenotyping.

[0094] **In a Third Aspect:** A ligand that binds a human PCSK9 comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 4-27 for use in a method comprising the step of using the ligand to target said PCSK9 in a human to treat and/or prevent a disease or condition mediated by PCSK9, the method comprising administering the ligand to the human.

[0095] In an example, the disease or condition is mediated by a human PCSK9 comprising an amino acid sequence

selected from the group consisting of SEQ ID NOs: 4-27.

[0096] In an example, the amino acid sequence selected from the group consisting of SEQ ID NOs: 4-23, 26 and 27; or selected from the group consisting of SEQ ID NOs: 4-14 and 18-27; or selected from the group consisting of SEQ ID NOs: 4-14, 18-23, 26 and 27. These are naturally-occurring sequences that do not comprise 46L and which meet the criteria set out above. These groups comprise variants that are associated with elevated LDL-C.

[0097] In an example, the amino acid sequence is SEQ ID NO: 18, 19 or 20, that comprises a 425S, which is associated with elevated LDL-C (Pisciotta et al 2006).

[0098] In an example, the amino acid sequence selected from the group consisting of SEQ ID NOs: 10, 11, 12, 26 and 27, that comprise 670G which is a marker for severity of coronary atherosclerosis (Chen et al 2005).

[0099] In an example, the amino acid sequence selected from the group consisting of SEQ ID NOs: 10-14 and 18-27; or selected from the group consisting of SEQ ID NOs: 10-14, 18-23, 26 and 27. These are sequences that have a naturally-occurring combination of differences from SEQ ID NOs: 1-3 (form a) and which meet the criteria set out above.

[0100] In an example, the amino acid sequence is SEQ ID NO: 4.

[0101] In an example, the amino acid sequence is SEQ ID NO: 5.

[0102] In an example, the amino acid sequence is SEQ ID NO: 6.

[0103] In an example, the amino acid sequence is SEQ ID NO: 7.

[0104] In an example, the amino acid sequence is SEQ ID NO: 8.

[0105] In an example, the amino acid sequence is SEQ ID NO: 9.

[0106] In an example, the amino acid sequence is SEQ ID NO: 10.

[0107] In an example, the amino acid sequence is SEQ ID NO: 11.

[0108] In an example, the amino acid sequence is SEQ ID NO: 12.

[0109] In an example, the amino acid sequence is SEQ ID NO: 13.

[0110] In an example, the amino acid sequence is SEQ ID NO: 14.

[0111] In an example, the amino acid sequence is SEQ ID NO: 15.

[0112] In an example, the amino acid sequence is SEQ ID NO: 16.

[0113] In an example, the amino acid sequence is SEQ ID NO: 17.

[0114] In an example, the amino acid sequence is SEQ ID NO: 18.

[0115] In an example, the amino acid sequence is SEQ ID NO: 19.

[0116] In an example, the amino acid sequence is SEQ ID NO: 20.

[0117] In an example, the amino acid sequence is SEQ ID NO: 21.

[0118] In an example, the amino acid sequence is SEQ ID NO: 22.

[0119] In an example, the amino acid sequence is SEQ ID NO: 23.

[0120] In an example, the amino acid sequence is SEQ ID NO: 24.

[0121] In an example, the amino acid sequence is SEQ ID NO: 25.

[0122] In an example, the amino acid sequence is SEQ ID NO: 26.

[0123] In an example, the amino acid sequence is SEQ ID NO: 27.

[0124] **In a Fourth Aspect:** The ligand of aspect 3, wherein the genome of the human comprises a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37.

[0125] In an example, the nucleotide sequence is selected from the group consisting of SEQ ID NOs: 29-35 and 37; or selected from the group consisting of SEQ ID NOs: 29-32 and 34-37; or selected from the group consisting of SEQ ID NOs: 29-32, 34, 35 and 37. These are naturally-occurring allele (haplotype) sequences that do not encode 46L and which meet the criteria set out above. These groups comprise variants that are associated with elevated LDL-C.

[0126] In an example, the nucleotide sequence is SEQ ID NO: 34, that encodes a 425S, which is associated with elevated LDL-C (Pisciotta *et al* 2006).

[0127] In an example, the nucleotide sequence selected from the group consisting of SEQ ID NOs: 31 and 37, that encode 670G which is a marker for severity of coronary atherosclerosis (Chen *et al* 2005).

[0128] In an example, the nucleotide sequence selected from the group consisting of SEQ ID NOs: 31, 32, 34, 35, 36 and 37; or selected from the group consisting of SEQ ID NOs: 31, 32, 34, 35 and 37. These are allele (haplotype) sequences that have a naturally-occurring combination of differences from SEQ ID NO: 28 (form *a*) and which meet the criteria set out above.

[0129] In an example, the nucleotide sequence is SEQ ID NO: 29.

[0130] In an example, the nucleotide sequence is SEQ ID NO: 30.

[0131] In an example, the nucleotide sequence is SEQ ID NO: 31.

[0132] In an example, the nucleotide sequence is SEQ ID NO: 32.

[0133] In an example, the nucleotide sequence is SEQ ID NO: 33.

[0134] In an example, the nucleotide sequence is SEQ ID NO: 34.

[0135] In an example, the nucleotide sequence is SEQ ID NO: 35.

[0136] In an example, the nucleotide sequence is SEQ ID NO: 36.

[0137] In an example, the nucleotide sequence is SEQ ID NO: 37.

[0138] **In a Fifth Aspect:** The ligand of any preceding aspect, wherein the human has been or is genotyped as positive for a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof.

[0139] In an example, the nucleotide sequence is selected from the group consisting of SEQ ID NOs: 29-35 and 37; or selected from the group consisting of SEQ ID NOs: 29-32 and 34-37; or selected from the group consisting of SEQ ID NOs: 29-32, 34, 35 and 37.

[0140] These are naturally-occurring allele (haplotype) sequences that do not encode 46L and which meet the criteria set out above. These groups comprise variants that are associated with elevated LDL-C.

[0141] In an example, the nucleotide sequence is SEQ ID NO: 34, that encodes a 425S, which is associated with elevated LDL-C (Pisciotta *et al* 2006).

[0142] In an example, the nucleotide sequence selected from the group consisting of SEQ ID NOs: 31 and 37, that encode 670G which is a marker for severity of coronary atherosclerosis (Chen *et al* 2005).

[0143] In an example, the nucleotide sequence selected from the group consisting of SEQ ID NOs: 31, 32, 34, 35, 36 and 37; or selected from the group consisting of SEQ ID NOs: 31, 32, 34, 35 and 37. These are allele (haplotype) sequences that have a naturally-occurring combination of differences from SEQ ID NO: 28 (form *a)* and which meet the criteria set out above.

[0144] In an example, the nucleotide sequence is SEQ ID NO: 29.

[0145] In an example, the nucleotide sequence is SEQ ID NO: 30.

[0146] In an example, the nucleotide sequence is SEQ ID NO: 31.

[0147] In an example, the nucleotide sequence is SEQ ID NO: 32.

[0148] In an example, the nucleotide sequence is SEQ ID NO: 33.

[0149] In an example, the nucleotide sequence is SEQ ID NO: 34.

[0150] In an example, the nucleotide sequence is SEQ ID NO: 35.

[0151] In an example, the nucleotide sequence is SEQ ID NO: 36.

[0152] In an example, the nucleotide sequence is SEQ ID NO: 37.

[0153] **In a Sixth Aspect:** The ligand of any preceding aspect, wherein the human has been or is phenotyped as positive for a human PCSK9 selected from the group consisting of forms *f, c, r, p, m, e, h, aj* and *q* or at least the catalytic or C-terminal domain thereof.

[0154] In an example, said forms are the mature forms.

[0155] In an example, said forms are the pro-forms.

[0156] **In a Seventh Aspect:** The ligand of any preceding aspect, wherein the method comprises genotyping the human as positive for a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof.

[0157] In an example, the nucleotide sequence is selected from the group consisting of SEQ ID NOs: 29-35 and 37; or selected from the group consisting of SEQ ID NOs: 29-32 and 34-37; or selected from the group consisting of SEQ ID NOs: 29-32, 34, 35 and 37. These are naturally-occurring allele (haplotype) sequences that do not encode 46L and which meet the criteria set out above. These groups comprise variants that are associated with elevated LDL-C.

[0158] In an example, the nucleotide sequence is SEQ ID NO: 34, that encodes a 425S, which is associated with elevated LDL-C (Pisciotta *et al* 2006).

[0159] In an example, the nucleotide sequence selected from the group consisting of SEQ ID NOs: 31 and 37, that encode 670G which is a marker for severity of coronary atherosclerosis (Chen *et al 2005).*

[0160] In an example, the nucleotide sequence selected from the group consisting of SEQ ID NOs: 31, 32, 34, 35, 36 and 37; or selected from the group consisting of SEQ ID NOs: 31, 32, 34, 35 and 37. These are allele (haplotype) sequences that have a naturally-occurring combination of differences from SEQ ID NO: 28 (form *a)* and which meet the criteria set out above.

[0161] In an example, the nucleotide sequence is SEQ ID NO: 29.

[0162] In an example, the nucleotide sequence is SEQ ID NO: 30.

[0163] In an example, the nucleotide sequence is SEQ ID NO: 31.

[0164] In an example, the nucleotide sequence is SEQ ID NO: 32.

[0165] In an example, the nucleotide sequence is SEQ ID NO: 33.

[0166] In an example, the nucleotide sequence is SEQ ID NO: 34.

[0167] In an example, the nucleotide sequence is SEQ ID NO: 35.

[0168] In an example, the nucleotide sequence is SEQ ID NO: 36.

[0169] In an example, the nucleotide sequence is SEQ ID NO: 37.

[0170] **In an Eight Aspect:** The ligand of any preceding aspect, wherein the method comprises phenotyping the human has positive for a human PCSK9 selected from the group consisting of forms *f, c, r, p, m, e, h, aj* and *q* or at least the catalytic or C-terminal domain thereof.

[0171] In an example, said forms are the mature forms.

[0172] In an example, said forms are the pro-forms.

[0173] **In a Ninth Aspect:** The ligand of any preceding aspect, wherein the human has been or is genotyped as heterozygous for a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof; optionally wherein the human has been or is genotyped as comprising the nucleotide sequence of SEQ ID NO: 28 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof and a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof.

[0174] "Heterozygous" here means that in the human's genotype one allele comprises a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof and other allele can be any PCSK9 (eg, form *a,* a'or an allele comprising a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof).

[0175] In an example, the method comprises (before administering the ligand) genotyping the human as heterozygous for a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof; optionally also genotyping the human as comprising the nucleotide sequence of SEQ ID NO: 28 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof and a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof.

[0176] In an example, the nucleotide sequence is selected from the group consisting of SEQ ID NOs: 29-35 and 37; or selected from the group consisting of SEQ ID NOs: 29-32 and 34-37; or selected from the group consisting of SEQ ID NOs: 29-32, 34, 35 and 37. These are naturally-occurring allele (haplotype) sequences that do not encode 46L and which meet the criteria set out above. These groups comprise variants that are associated with elevated LDL-C.

[0177] In an example, the nucleotide sequence is SEQ ID NO: 34, that encodes a 425S, which is associated with elevated LDL-C (Pisciotta et al 2006).

[0178] In an example, the nucleotide sequence selected from the group consisting of SEQ ID NOs: 31 and 37, that encode 670G which is a marker for severity of coronary atherosclerosis (Chen *et al* 2005).

[0179] In an example, the nucleotide sequence selected from the group consisting of SEQ ID NOs: 31, 32, 34, 35, 36 and 37; or selected from the group consisting of SEQ ID NOs: 31, 32, 34, 35 and 37. These are allele (haplotype) sequences that have a naturally-occurring combination of differences from SEQ ID NO: 28 (form *a)* and which meet the criteria set out above.

[0180] In an example, the nucleotide sequence is SEQ ID NO: 29.

[0181] In an example, the nucleotide sequence is SEQ ID NO: 30.

[0182] In an example, the nucleotide sequence is SEQ ID NO: 31.

[0183] In an example, the nucleotide sequence is SEQ ID NO: 32.

[0184] In an example, the nucleotide sequence is SEQ ID NO: 33.

[0185] In an example, the nucleotide sequence is SEQ ID NO: 34.

[0186] In an example, the nucleotide sequence is SEQ ID NO: 35.

[0187] In an example, the nucleotide sequence is SEQ ID NO: 36.

[0188] In an example, the nucleotide sequence is SEQ ID NO: 37.

[0189] **In a Tenth Aspect:** The ligand of any one of aspects 1 to 9, wherein the genome of the human has been or is genotyped as homozygous for a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof.

[0190] "Homozygous" here means that in the human's genotype each allele comprises the same nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof.

[0191] In an example, the method comprises genotyping the human as homozygous for a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof.

[0192] In an example, the nucleotide sequence is selected from the group consisting of SEQ ID NOs: 29-35 and 37; or selected from the group consisting of SEQ ID NOs: 29-32 and 34-37; or selected from the group consisting of SEQ ID NOs: 29-32, 34, 35 and 37. These are naturally-occurring allele (haplotype) sequences that do not encode 46L and which meet the criteria set out above. These groups comprise variants that are associated with elevated LDL-C.

[0193] In an example, the nucleotide sequence is SEQ ID NO: 34, that encodes a 425S, which is associated with elevated LDL-C (Pisciotta et al 2006).

[0194] In an example, the nucleotide sequence selected from the group consisting of SEQ ID NOs: 31 and 37, that encode 670G which is a marker for severity of coronary atherosclerosis (Chen *et al 2005).*

[0195] In an example, the nucleotide sequence selected from the group consisting of SEQ ID NOs: 31, 32, 34, 35, 36

and 37; or selected from the group consisting of SEQ ID NOs: 31, 32, 34, 35 and 37. These are allele (haplotype) sequences that have a naturally-occurring combination of differences from SEQ ID NO: 28 (form *a)* and which meet the criteria set out above.

[0196] In an example, the nucleotide sequence is SEQ ID NO: 29.

[0197] In an example, the nucleotide sequence is SEQ ID NO: 30.

[0198] In an example, the nucleotide sequence is SEQ ID NO: 31.

[0199] In an example, the nucleotide sequence is SEQ ID NO: 32.

[0200] In an example, the nucleotide sequence is SEQ ID NO: 33.

[0201] In an example, the nucleotide sequence is SEQ ID NO: 34.

[0202] In an example, the nucleotide sequence is SEQ ID NO: 35.

[0203] In an example, the nucleotide sequence is SEQ ID NO: 36.

[0204] In an example, the nucleotide sequence is SEQ ID NO: 37.

[0205] **In an Eleventh Aspect:** The ligand of any preceding aspect, wherein the ligand comprises an antibody binding site that binds a human PCSK9 comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 4-27 and optionally has been or is determined as capable of such binding.

[0206] In an example, the method comprises (before administering the ligand) the step of determining that the ligand is capable of binding to said human PCSK9.

[0207] In an example, the binding is specific binding. In an example, the ligand binds (or has been determined as binding) to the PCSK9 with an affinity (Kd) of 1mM, 100nM, 10nM or 1nM or less. In an embodiment, the affinity is no less than 10, 100 or 1000 fM.

[0208] In an example, binding or affinity is determined by SPR or ELISA.

[0209] In an example, the disease or condition is mediated by a human PCSK9 comprising an amino acid sequence selected from the group consisting of SEQ ID NOs: 4-27.

[0210] In an example, the amino acid sequence selected from the group consisting of SEQ ID NOs: 4-23, 26 and 27; or selected from the group consisting of SEQ ID NOs: 4-14 and 18-27; or selected from the group consisting of SEQ ID NOs: 4-14, 18-23, 26 and 27. These are naturally-occurring sequences that do not comprise 46L and which meet the criteria set out above. These groups comprise variants that are associated with elevated LDL-C.

[0211] In an example, the amino acid sequence is SEQ ID NO: 18, 19 or 20, that comprises a 425S, which is associated with elevated LDL-C (Pisciotta et al 2006).

[0212] In an example, the amino acid sequence selected from the group consisting of SEQ ID NOs: 10, 11, 12, 26 and 27, that comprise 670G which is a marker for severity of coronary atherosclerosis (Chen et al 2005).

[0213] In an example, the amino acid sequence selected from the group consisting of SEQ ID NOs: 10-14 and 18-27; or selected from the group consisting of SEQ ID NOs: 10-14, 18-23, 26 and 27. These are sequences that have a naturally-occurring combination of differences from SEQ ID NOs: 1-3 (form a) and which meet the criteria set out above.

[0214] In an example, the amino acid sequence is SEQ ID NO: 4.

[0215] In an example, the amino acid sequence is SEQ ID NO: 5.

[0216] In an example, the amino acid sequence is SEQ ID NO: 6.

[0217] In an example, the amino acid sequence is SEQ ID NO: 7.

[0218] In an example, the amino acid sequence is SEQ ID NO: 8.

[0219] In an example, the amino acid sequence is SEQ ID NO: 9.

[0220] In an example, the amino acid sequence is SEQ ID NO: 10.

[0221] In an example, the amino acid sequence is SEQ ID NO: 11.

[0222] In an example, the amino acid sequence is SEQ ID NO: 12.

[0223] In an example, the amino acid sequence is SEQ ID NO: 13.

[0224] In an example, the amino acid sequence is SEQ ID NO: 14.

[0225] In an example, the amino acid sequence is SEQ ID NO: 15.

[0226] In an example, the amino acid sequence is SEQ ID NO: 16.

[0227] In an example, the amino acid sequence is SEQ ID NO: 17.

[0228] In an example, the amino acid sequence is SEQ ID NO: 18.

[0229] In an example, the amino acid sequence is SEQ ID NO: 19.

[0230] In an example, the amino acid sequence is SEQ ID NO: 20.

[0231] In an example, the amino acid sequence is SEQ ID NO: 21.

[0232] In an example, the amino acid sequence is SEQ ID NO: 22.

[0233] In an example, the amino acid sequence is SEQ ID NO: 23.

[0234] In an example, the amino acid sequence is SEQ ID NO: 24.

[0235] In an example, the amino acid sequence is SEQ ID NO: 25.

[0236] In an example, the amino acid sequence is SEQ ID NO: 26.

[0237] In an example, the amino acid sequence is SEQ ID NO: 27.

[0238] **In a Twelfth Aspect:** The ligand of aspect 11, wherein the ligand is an antibody or antibody fragment. For example, the antibody or antibody fragment is a PCSK9 antagonist, eg, neutralises PCSK9. Examples of such antibodies are disclosed, for instance, in WO 2008/057457, WO2008/057458, WO 2008/057459, WO 2008/063382, WO 2008/133647, WO 2009/100297, WO 2009/100318, WO 201 1/037791, WO 201 1/053759, WO 201 1/053783, WO 2008/125623, WO 2011/072263, WO 2009/055783, WO 2010/029513, WO 2011/11 1007, WO 2010/077854, the disclosures and sequences of such antibodies being incorporated herein in their entireties by refere for use in the invention. One specific example is AMG 145 (Amgen), LY3015014 (Eli Lilly) or alirocumab, or a PCSK9-binding derivative thereof. Advantageously, the ligand is or comprises alirocumab.

[0239] Alternatively, the ligand is or comprises evolocumab.

[0240] In an example, the ligand is SAR236553/REGN727 (Sanofi Aventis/Regeneron) or a PCSK9-binding derivative thereof.

[0241] In an example, the ligand comprises or consists of a neutralizing antibody that binds to the PCSK9, wherein the antibody binds to PCSK9 and reduces the likelihood that PCSK9 binds to LDLR.

[0242] The ligand of aspect 11, wherein the ligand is a PCSK9 antagonist, eg, neutralises PCSK9.

[0243] In an example of any aspect of the invention, the ligand comprises or consists a ligand selected from evolocumab, 1D05-IgG2 (Merck & Co.), ALN-PCS02 (Alnylam), RN316 (Pfizer-Rinat), LY3015014 (Eli Lilly) and alirocumab, or a PCSK9-binding derivative thereof. In an example, the ligand is SAR236553/REGN727 (Sanofi Aventis/Regeneron) or a PCSK9-binding derivative thereof.

[0244] **In a Thirteenth Aspect:** The ligand of any one of aspects 1 to 10, wherein (i) the ligand comprises a sequence of contiguous nucleotides that specifically hybridises to a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof, or specifically hybridises to an antisense sequence or an RNA transcript of said sequence, wherein said sequence of contiguous nucleotides hybridises to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridises to an antisense sequence or an RNA transcript thereof respectively; and/or (ii) the ligand comprises a sequence of at least 10 contiguous nucleotides of a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or is an antisense sequence or RNA version of said contiguous nucleotides, wherein said sequence of contiguous nucleotides comprises at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28.

[0245] In an example, the nucleotide sequence is selected from the group consisting of SEQ ID NOs: 29-35 and 37; or selected from the group consisting of SEQ ID NOs: 29-32 and 34-37; or selected from the group consisting of SEQ ID NOs: 29-32, 34, 35 and 37. These are naturally-occurring allele (haplotype) sequences that do not encode 46L and which meet the criteria set out above. These groups comprise variants that are associated with elevated LDL-C.

[0246] In an example, the nucleotide sequence is SEQ ID NO: 34, that encodes a 425S, which is associated with elevated LDL-C (Pisciotta *et al* 2006).

[0247] In an example, the nucleotide sequence selected from the group consisting of SEQ ID NOs: 31 and 37, that encode 670G which is a marker for severity of coronary atherosclerosis (Chen *et al* 2005).

[0248] In an example, the nucleotide sequence selected from the group consisting of SEQ ID NOs: 31, 32, 34, 35, 36 and 37; or selected from the group consisting of SEQ ID NOs: 31, 32, 34, 35 and 37. These are allele (haplotype) sequences that have a naturally-occurring combination of differences from SEQ ID NO: 28 (form *a*) and which meet the criteria set out above.

[0249] In an example, the nucleotide sequence is SEQ ID NO: 29.

[0250] In an example, the nucleotide sequence is SEQ ID NO: 30.

[0251] In an example, the nucleotide sequence is SEQ ID NO: 31.

[0252] In an example, the nucleotide sequence is SEQ ID NO: 32.

[0253] In an example, the nucleotide sequence is SEQ ID NO: 33.

[0254] In an example, the nucleotide sequence is SEQ ID NO: 34.

[0255] In an example, the nucleotide sequence is SEQ ID NO: 35.

[0256] In an example, the nucleotide sequence is SEQ ID NO: 36.

[0257] In an example, the nucleotide sequence is SEQ ID NO: 37.

[0258] In an embodiment, the ligand comprises at least 10, 11, 12, 13, 14, 15, 20, 25, 30, 35, 40, 45, 50 or 100 contiguous nucleotides of said nucleotide sequence.

[0259] **In a Fourteenth Aspect:** The ligand of any preceding aspect, wherein said disease or condition is hyperlipidaemia, hypercholesterolaemia (eg, familial hypercholesterolaemia), heart attack, stroke, coronary heart disease, atherosclerosis or a cardiovascular disease or condition.

[0260] The ligand of any preceding aspect, wherein the disease or condition is hypercholesterolemia, hyperlipidemia, hypercholesterolemia, dyslipidemia, cholestatic liver disease, nephrotic syndrome, hypothyroidism, obesity, atherosclerosis or a cardiovascular disease.

[0261] In an example, said disease or condition is hypercholesterolaemia. The term "hypercholesterolaemia," as used

herein, refers to a condition in which cholesterol levels are elevated above a desired level. In some embodiments, this denotes that serum cholesterol levels are elevated. In some embodiments, the desired level takes into account various "risk factors" that are known to one of skill in the art (and are described or referenced in US20120093818).

[0262] The ligand of any preceding aspect, wherein the human is identified as heterozygous for Familial Hypercholesterolemia, statin intolerant, statin uncontrolled, or at risk for developing hypercholesterolemia, dyslipidemia, cholestatic liver disease, nephrotic syndrome, hypothyroidism, obesity, atherosclerosis or a cardiovascular disease.

[0263] **In a Fifteenth Aspect:** The ligand of any preceding aspect, wherein said disease or condition is associated with elevated LDL cholesterol.

[0264] Cholesterol levels are measured in milligrams (mg) of cholesterol per deciliter (dL) of blood in the United States and some other countries. Canada and most European countries measure cholesterol in millimoles (mmol) per liter (L) of blood. Below are general guideline ideal ranges and elevated ranges.

Total cholesterol (U.S. and some other countries)	**Total cholesterol* (Canada and most of Europe)**	
Below 200 mg/dL	Below 5.2 mmol/L	Ideal
200-239 mg/dL	5.2-6.2 mmol/L	Borderline high
240 mg/dL and above	Above 6.2 mmol/L	High

LDL cholesterol (U.S. and some other countries)	**LDL cholesterol* (Canada and most of Europe)**	
100-129 mg/dL	2.6-3.3 mmol/L	Ideal
130-159 mg/dL	3.4-4.1 mmol/L	Borderline high
160-189 mg/dL	4.1-4.9 mmol/L	High
190 mg/dL and above	Above 4.9 mmol/L	Very high

*Canadian and European guidelines differ slightly from U.S. guidelines. These conversions are based on U.S. guidelines.

[0265] Elevated LDL cholesterol is, therefore, 160 mg/dL or above (4.1 mmol/L or above).

[0266] **In a Sixteenth Aspect:** The ligand of any preceding aspect, wherein the ligand inhibits human PCSK9 binding to human LDL receptor and optionally has been or is determined as capable of such inhibition.

[0267] In an example, the method comprises (before administering the ligand) determining that the ligand is capable of such inhibition.

[0268] Inhibition determination is eg, inhibition in a blood or serum sample, at rtp, at pH7, at 37 degrees centigrade and/or under the physiological conditions of a human body.

[0269] **In a Seventeenth Aspect:** The ligand of any preceding aspect, wherein the human is resistant or substantially resistant to statin (eg, avorstatin and/or fluvastatin) treatment of said disease or condition.

[0270] **In an Eighteenth Aspect:** The ligand of any preceding aspect, wherein the ligand is for treating and/or preventing a PCSK9-mediated disease or condition in a human

(i) whose genome comprises SEQ ID NO: 29 and wherein the human is of ASW,YRI,GBR,TSI, CLM,LWK,MXL,JPT,PUR,IBS,FIN or CEU ancestry; or
(ii) whose genome comprises SEQ ID NO: 30 and wherein the human is of ASW,YRI,GBR,TSI,CLM, CHB,LWK,CHS,JPT,PUR,FIN or CEU ancestry; or
(iii) whose genome comprises SEQ ID NO: 32 and wherein the human is of ASW,GBR,TSI,CLM, JPT,PUR,IBS,FIN or CEU ancestry; or
(iv) whose genome comprises SEQ ID NO: 33 and wherein the human is of LWK,ASW,YRI or CLM ancestry; or
(v) whose genome comprises SEQ ID NO: 34 and wherein the human is of LWK,ASW or YRI ancestry; or
(vi) whose genome comprises SEQ ID NO: 35 and wherein the human is of PUR,TSI,FIN or CEU ancestry; or
(vii) whose genome comprises SEQ ID NO: 36 and wherein the human is of LWK,ASW or YRI ancestry; or
(viii) whose genome comprises SEQ ID NO: 37 and wherein the human is of CHS,ASW,JPT,PUR or CHB ancestry.

[0271] **In a Nineteenth Aspect:** The ligand of any preceding aspect, wherein the ligand is for treating and/or preventing a PCSK9-mediated disease or condition in a human

(i) that expresses PCSK9 form fand wherein the human is of ASW,YRI,GBR,TSI,CLM,LWK,MXL,JPT,PUR,IBS,FIN or CEU ancestry; or

(ii) that expresses PCSK9 form *c* and wherein the human is of ASW,YRI,GBR,TSI,CLM,CHB,LWK,CHS,JPT,PUR,FIN or CEU ancestry; or
(iii) that expresses PCSK9 form *p* and wherein the human is of ASW,GBR,TSI,CLM,JPT,PUR,IBS,FIN or CEU ancestry; or
(iv) that expresses PCSK9 form *m* and wherein the human is of LWK,ASW,YRI or CLM ancestry; or
(v) that expresses PCSK9 form *e* and wherein the human is of LWK,ASW or YRI ancestry; or
(vi) that expresses PCSK9 form *h* and wherein the human is of PUR,TSI,FIN or CEU ancestry; or
(vii) that expresses PCSK9 form *aj* and wherein the human is of LWK,ASW or YRI ancestry; or
(viii) that expresses PCSK9 form *q* and wherein the human is of CHS,ASW,JPT,PUR or CHB ancestry.

[0272] In an example, said forms are the mature forms.

[0273] In an example, said forms are the pro-forms.

[0274] **In a Twentieth Aspect:** A pharmaceutical composition or kit for treating and/or preventing a PCSK9-mediated condition or disease (eg, as recited in aspect 14 or 15), the composition or kit comprising a ligand of any preceding aspect and optionally a statin (eg, cerovastatin, atorvastatin, simvastatin, pitavastin, rosuvastatin, fluvastatin, lovastatin or pravastatin); and optionally in combination with a label or instructions for use to treat and/or prevent said disease or condition in a human (eg, covering treatment of a human as recited in aspect 18 or 19); optionally wherein the label or instructions comprise a marketing authorisation number (eg, an FDA or EMA authorisation number); optionally wherein the label or instructions comprise directions to administer alirocumab or evolocumab to said human; optionally wherein the kit comprises an IV or injection device that comprises the ligand (and, eg, also a statin).

[0275] **In a Twenty-first Aspect:** A method of producing an anti-human PCSK9 antibody binding site, the method comprising obtaining a plurality of anti-PCSK9 antibody binding sites, screening the antibody binding sites for binding to a human PCSK9 selected from the group consisting of forms *f, c, r, p, m, e, h, aj* and *q* or a catalytic or C-terminal domain or a peptide thereof that comprises amino acid variation from the corresponding sequence of SEQ ID NO: 1, 2 or 3 and isolating an antibody binding site that binds in the screening step, and optionally producing a form *f, c, r, p, m, e, h, aj* or *q* PCSK9-binding fragment or derivative of the isolated antibody.

[0276] In an example, said forms are the mature forms.

[0277] In an example, said forms are the pro-forms.

[0278] In an example of this and the next aspect, the plurality of binding sites comprises or consists of a plurality of 4-chain antibodies or fragments thereof, eg, dAbs, Fabs or scFvs. Suitable methods for producing pluralities of binding sites for screening include phage display (producing a phage display library of antibody binding sites), ribosome display (producing a ribosome display library of antibody binding sites), yeast display (producing a yeast display library of antibody binding sites), or immunisation of a non-human vertebrate (eg, a rodent, eg, a mouse or rat, eg, a Velocimouse™, Kymouse™, Xenomouse™, Aliva Mouse™, HuMab Mouse™, Omnimouse™, Omnirat™ or MeMo Mouse™) with a PCSK9 epitope and isolation of a repertoire of antibody-producing cells (eg, a B-cell, plasma cell or plasmablast repertoire) and/or a repertoire of isolated antibodies.

[0279] In an example, the method comprises selecting one or more antibody binding sites that each specifically binds to a human PCSK9 epitope comprising amino acid variation from the corresponding sequence of SEQ ID NO: 1, 2 or 3.

[0280] For example, the ligand specifically binds to an epitope comprising an amino acid that is variant compared to the corresponding amino acid of the PCSK9 encoded by SEQ ID NO: 1, 2 or 3. In an example, the ligand specifically binds to an epitope comprising two or more such variant amino acids. In an example, specific binding means binding with an affinity (Kd) of 1mM, 100nM, 10nM or 1nM or less, eg, as determined by SPR.

[0281] The term "epitope" is a region of an antigen that is bound by an antibody. Epitopes may be defined as structural or functional. Functional epitopes are generally a subset of the structural epitopes and have those residues that directly contribute to the affinity of the interaction. Epitopes may also be conformational, that is, composed of non-linear amino acids. In certain embodiments, epitopes may include determinants that are chemically active surface groupings of molecules such as amino acids, sugar side chains, phosphoryl groups, or sulfonyl groups, and, in certain embodiments, may have specific three-dimensional structural characteristics, and/or specific charge characteristics.

[0282] **In a Twenty-second Aspect:** A method of producing an anti-human PCSK9 antibody, the method comprising immunising a non-human vertebrate (eg, a mouse or a rat) with a human PCSK9 comprising an amino acid sequence selected from the group consisting of the amino acid sequences of forms *f, c, r, p, m, e, h, aj* and *q* or a catalytic or C-terminal domain or a peptide thereof that comprises amino acid variation from the corresponding sequence of SEQ ID NO: 1, 2 or 3 and isolating an antibody that binds a human PCSK9 comprising selected from the group consisting of forms *f, c, r, p, m, e, h, aj* and *q* or a catalytic or C-terminal domain or a peptide thereof that comprises amino acid variation from the corresponding sequence of SEQ ID NO: 1, 2 or 3, and optionally producing a form *f, c, r, p, m, e, h, aj* or *q* PCSK9-binding fragment or derivative of the isolated antibody.

[0283] In an example, said forms are the mature forms.

[0284] In an example, said forms are the pro-forms.

[0285] **In a Twenty-third Aspect:** The method of aspect 21 or 22, comprising the step of obtaining a nucleic acid encoding the antibody, fragment, derivative or binding site and optionally inserting the nucleic acid in an expression vector.

[0286] For example, the method comprises isolating a cell (eg, B-cell, plasmablast, plasma cell or memory cell) comprising the nucleic acid, wherein the cell is obtained from a non-human vertebrate that has been immunised with the PCSK9 epitope.

[0287] **In a Twenty-fourth Aspect:** A kit for PCSK9 genotyping a human, wherein the kit comprises a nucleic acid (i) comprising a sequence of 10 or more (eg, 10, 15, 20, 30, 40, 50, 60, 70, 80, 90, 100 or more) contiguous nucleotides that specifically hybridises to a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof, or specifically hybridises to an antisense sequence or an RNA transcript of said sequence, wherein said sequence of contiguous nucleotides hybridises to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridises to an antisense sequence or an RNA transcript thereof; and/or (ii) comprising a sequence of at least 10 or more (eg, 10, 15, 20, 30, 40, 50, 60, 70, 80, 90, 100 or more) nucleotides of a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or comprising an antisense sequence or RNA version of said contiguous nucleotides, wherein said sequence of contiguous nucleotides comprises at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28.

[0288] In an example, the nucleotide sequence is selected from the group consisting of SEQ ID NOs: 29-35 and 37; or selected from the group consisting of SEQ ID NOs: 29-32 and 34-37; or selected from the group consisting of SEQ ID NOs: 29-32, 34, 35 and 37. These are naturally-occurring allele (haplotype) sequences that do not encode 46L and which meet the criteria set out above. These groups comprise variants that are associated with elevated LDL-C.

[0289] In an example, the nucleotide sequence is SEQ ID NO: 34, that encodes a 425S, which is associated with elevated LDL-C (Pisciotta et al 2006).

[0290] In an example, the nucleotide sequence selected from the group consisting of SEQ ID NOs: 31 and 37, that encode 670G which is a marker for severity of coronary atherosclerosis (Chen *et al* 2005).

[0291] In an example, the nucleotide sequence selected from the group consisting of SEQ ID NOs: 31, 32, 34, 35, 36 and 37; or selected from the group consisting of SEQ ID NOs: 31, 32, 34, 35 and 37. These are allele (haplotype) sequences that have a naturally-occurring combination of differences from SEQ ID NO: 28 (form *a*) and which meet the criteria set out above.

[0292] In an example, the nucleotide sequence is SEQ ID NO: 29.

[0293] In an example, the nucleotide sequence is SEQ ID NO: 30.

[0294] In an example, the nucleotide sequence is SEQ ID NO: 31.

[0295] In an example, the nucleotide sequence is SEQ ID NO: 32.

[0296] In an example, the nucleotide sequence is SEQ ID NO: 33.

[0297] In an example, the nucleotide sequence is SEQ ID NO: 34.

[0298] In an example, the nucleotide sequence is SEQ ID NO: 35.

[0299] In an example, the nucleotide sequence is SEQ ID NO: 36.

[0300] In an example, the nucleotide sequence is SEQ ID NO: 37.

[0301] **In a Twenty-fifth Aspect:**

A kit for PCSK9 genotyping or phenotyping a human, wherein the kit comprises a ligand according to any one of aspects 1 to 19 or an antibody, fragment or derivative produced by the method of any one of aspects 21 to 23.

[0302] **In a Twenty-sixth Aspect:** Use of an anti-PCSK9 ligand that binds a human PCSK9 selected from the group consisting of forms *f, c, r, p, m, e, h, aj* and *q* in the manufacture of a medicament for treating and/or preventing a PCSK9-mediated disease or condition in a human whose genome comprises a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37, optionally for treating and/or preventing a PCSK9-mediated disease or condition in a human as recited in aspect 18 or 19.

[0303] In an example, said forms are the mature forms.

[0304] In an example, said forms are the pro-forms.

[0305] **In a Twenty-seventh Aspect:** Use of an anti-PCSK9 ligand that binds a human PCSK9 selected from the group consisting of forms *f, c, r, p, m, e, h, aj* and *q* in the manufacture of a medicament for targeting said PCSK9 in a human to treat and/or prevent a disease or condition mediated by PCSK9, optionally for targeting PCSK9 in a human as recited in aspect 18 or 19.

[0306] In an example, said forms are the mature forms.

[0307] In an example, said forms are the pro-forms.

[0308] In an example, the nucleotide sequence is selected from the group consisting of SEQ ID NOs: 29-35 and 37; or selected from the group consisting of SEQ ID NOs: 29-32 and 34-37; or selected from the group consisting of SEQ ID NOs: 29-32, 34, 35 and 37. These are naturally-occurring allele (haplotype) sequences that do not encode 46L and which meet the criteria set out above. These groups comprise variants that are associated with elevated LDL-C.

[0309] In an example, the nucleotide sequence is SEQ ID NO: 34, that encodes a 425S, which is associated with

elevated LDL-C (Pisciotta *et al* 2006).

[0310] In an example, the nucleotide sequence selected from the group consisting of SEQ ID NOs: 31 and 37, that encode 670G which is a marker for severity of coronary atherosclerosis (Chen *et al* 2005).

[0311] In an example, the nucleotide sequence selected from the group consisting of SEQ ID NOs: 31, 32, 34, 35, 36 and 37; or selected from the group consisting of SEQ ID NOs: 31, 32, 34, 35 and 37. These are allele (haplotype) sequences that have a naturally-occurring combination of differences from SEQ ID NO: 28 (form *a*) and which meet the criteria set out above.

[0312] In an example, the nucleotide sequence is SEQ ID NO: 29.

[0313] In an example, the nucleotide sequence is SEQ ID NO: 30.

[0314] In an example, the nucleotide sequence is SEQ ID NO: 31.

[0315] In an example, the nucleotide sequence is SEQ ID NO: 32.

[0316] In an example, the nucleotide sequence is SEQ ID NO: 33.

[0317] In an example, the nucleotide sequence is SEQ ID NO: 34.

[0318] In an example, the nucleotide sequence is SEQ ID NO: 35.

[0319] In an example, the nucleotide sequence is SEQ ID NO: 36.

[0320] In an example, the nucleotide sequence is SEQ ID NO: 37.

[0321] The ligand can be any anti-PCSK9 ligand disclosed herein.

[0322] **In a Twenty-eighth Aspect:** The use of aspect 26 or 27, wherein the ligand, human, disease or condition is according to any one of aspects 1 to 19.

[0323] **In a Twenty-ninth Aspect:** A method of targeting a PCSK9 for treating and/or preventing a PCSK9-mediated disease or condition in a human, the method comprising administering an anti-PCSK9 ligand to a human comprising a nucleotide sequence selected from the group consisting SEQ ID NOs: 29-37, whereby a PCSK9 encoded by said nucleotide sequence is targeted.

[0324] The ligand can be any anti-PCSK9 ligand disclosed herein.

[0325] **In a Thirtieth Aspect:** The method of aspect 29, wherein the method comprises targeting a human PCSK9 selected from the group consisting of forms *f, c, r, p, m, e, h, ajand q* with said ligand to treat and/or prevent said disease or condition in said human.

[0326] In an example, said forms are the mature forms.

[0327] In an example, said forms are the pro-forms.

[0328] **In a Thirty-first Aspect:** A method of treating and/or preventing a disease or condition mediated by PCSK9 in a human, the method comprising targeting a human PCSK9 selected from the group consisting of forms *f, c, r, p, m, e, h, aj* and *q* by administering to the human a ligand that binds said PCSK9 thereby treating and/or preventing said disease or condition in the human.

[0329] In an example, said forms are the mature forms.

[0330] In an example, said forms are the pro-forms.

[0331] The ligand can be any anti-PCSK9 ligand disclosed herein.

[0332] **In a Thirty-second Aspect:** The method of aspect 31, wherein the genome of the human comprises a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37.

[0333] In an example, the nucleotide sequence is selected from the group consisting of SEQ ID NOs: 29-35 and 37; or selected from the group consisting of SEQ ID NOs: 29-32 and 34-37; or selected from the group consisting of SEQ ID NOs: 29-32, 34, 35 and 37. These are naturally-occurring allele (haplotype) sequences that do not encode 46L and which meet the criteria set out above. These groups comprise variants that are associated with elevated LDL-C.

[0334] In an example, the nucleotide sequence is SEQ ID NO: 34, that encodes a 425S, which is associated with elevated LDL-C (Pisciotta *et al* 2006).

[0335] In an example, the nucleotide sequence selected from the group consisting of SEQ ID NOs: 31 and 37, that encode 670G which is a marker for severity of coronary atherosclerosis (Chen *et al* 2005).

[0336] In an example, the nucleotide sequence selected from the group consisting of SEQ ID NOs: 31, 32, 34, 35, 36 and 37; or selected from the group consisting of SEQ ID NOs: 31, 32, 34, 35 and 37. These are allele (haplotype) sequences that have a naturally-occurring combination of differences from SEQ ID NO: 28 (form *a*) and which meet the criteria set out above.

[0337] In an example, the nucleotide sequence is SEQ ID NO: 29.

[0338] In an example, the nucleotide sequence is SEQ ID NO: 30.

[0339] In an example, the nucleotide sequence is SEQ ID NO: 31.

[0340] In an example, the nucleotide sequence is SEQ ID NO: 32.

[0341] In an example, the nucleotide sequence is SEQ ID NO: 33.

[0342] In an example, the nucleotide sequence is SEQ ID NO: 34.

[0343] In an example, the nucleotide sequence is SEQ ID NO: 35.

[0344] In an example, the nucleotide sequence is SEQ ID NO: 36.

[0345] In an example, the nucleotide sequence is SEQ ID NO: 37.

[0346] **In a Thirty-third Aspect:** The method of any one of aspects 29 to 32, wherein the human has been or is genotyped as positive for a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or the catalytic- or C-terminal domain-encoding sequence thereof.

[0347] **In a Thirty-fourth Aspect:** The method of any one of aspects 29 to 33, wherein the human has been or is phenotyped as positive for a human PCSK9 selected from the group consisting of forms *f, c, r, p, m, e, h, aj* and *q.*

[0348] In an example, said forms are the mature forms.

[0349] In an example, said forms are the pro-forms.

[0350] **In a Thirty-fifth Aspect:** The method of any one of aspects 29 to 34, wherein the method comprises genotyping the human as positive for a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or the catalytic- or C-terminal domain-encoding sequence thereof.

[0351] **In a Thirty-sixth Aspect:** The method of any one of aspects 29 to 35, wherein the method comprises phenotyping the human as positive for a human PCSK9 sequence selected from the group consisting of forms *f, c, r, p, m, e, h, aj* and *q.*

[0352] In an example, said forms are the mature forms.

[0353] In an example, said forms are the pro-forms.

[0354] **In a Thirty-seventh Aspect:** The method of any one of aspects 29 to 36, wherein the human has been or is genotyped as heterozygous for a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or the catalytic- or C-terminal domain-encoding sequence thereof; optionally wherein the human has been or is genotyped as comprising the nucleotide sequence of SEQ ID NO: 28 or the catalytic- or C-terminal domain-encoding sequence thereof and a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or the catalytic- or C-terminal domain-encoding sequence thereof.

[0355] **In a Thirty-eighth Aspect:** The method of any one of aspects 29 to 37, wherein the genome of the human has been or is genotyped as homozygous for a nucleotide sequence selected from the group consisting of of SEQ ID NOs: 29-37 or the catalytic- or C-terminal domain-encoding sequence thereof.

[0356] **In a Thirty-ninth Aspect:** The method of any one of aspects 29 to 38, wherein the method comprises genotyping the human for a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or the catalytic- or C-terminal domain-encoding sequence thereof before administering the ligand to the human, wherein the ligand is determined to be capable of binding to a PCSK9 encoded by said selected sequence.

[0357] **In a Fortieth Aspect:** The method of any one of aspects 29 to 39, wherein the ligand, human, disease or condition is according to any one of aspects 1 to 19.

[0358] **In a Forty-first Aspect:** A method according to any one of aspects 29 to 40 for treating and/or preventing a condition or disease as recited in aspect 14 or 15, the method comprising administering said ligand and a statin (eg, cerovastatin, atorvastatin, simvastatin, pitavastin, rosuvastatin, fluvastatin, lovastatin or pravastatin) to the human.

[0359] **In a Forty-second Aspect:** The method of aspect 41, wherein the ligand and statin are administered separately.

[0360] **In a Forty-third Aspect:** The method of aspect 41, wherein the ligand and statin are administered simultaneously.

[0361] **In a Forty-fourth Aspect:** The method of any one of aspects 29 to 43, wherein the ligand is administered by subcutaneous injection.

[0362] **In a Forty-fifth Aspect:** A method of PCSK9 genotyping a nucleic acid sample of a human, the method comprising identifying in the sample the presence of a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or the catalytic- or C-terminal domain-encoding sequence thereof.

[0363] **In a Forty-sixth Aspect:** A method of PCSK9 typing a protein sample of a human, the method comprising identifying in the sample the presence of a human PCSK9 selected from the group consisting of forms *f, c, r, p, m, e, h, aj* and *q*.

[0364] In an example, said forms are the mature forms.

[0365] In an example, said forms are the pro-forms.

[0366] In an example, the method comprises obtaining a PCSK9 protein sample from the human and then carrying out the identifying step.

[0367] **In a Forty-seventh Aspect:** The method of aspect 45 or 46, comprising obtaining a sample of serum, blood, faeces, hair, tissue, cells, urine or saliva from a human, whereby the nucleic acid or protein sample is obtained and used in the step of identifying said sequence.

[0368] **In a Forty-eight Aspect:** The method of any one of aspects 45 to 47, comprising using a ligand according to any one of aspects 1 to 19 to carry out said identifying step.

[0369] **In a Forty-ninth Aspect:** A method of treating and/or preventing in a human patient a cardiovascular disease or condition, or a disease or condition that is associated with elevated LDL cholesterol (eg, hypercholesterolaemia), wherein the patient is receiving or has previously received statin treatment for said disease or condition, the method comprising typing the patient using a method of any one of aspects 45 to 48 and administering a ligand according to

one of aspects 1 to 19 whereby the human is treated or said disease or condition is prevented; optionally also reducing or stopping statin treatment.

[0370] In an example, said reducing or stopping comprises reducing the dose and/or dosing frequency of statin.

[0371] **In a Fiftieth Aspect:** A diagnostic, therapeutic or prophylactic kit comprising a ligand that is capable of binding to or has been or is determined as capable of binding to an amino acid sequence selected from SEQ ID NOs: 4-27 and instructions for carrying out the method of any one of aspects 46 to 49 and/or a label or instructions indicating or covering administration of the ligand to a human as defined in any one of aspects 1 to 19.

[0372] **In a Fifty-first Aspect:** A diagnostic, therapeutic or prophylactic kit comprising a nucleic acid probe comprising a nucleotide sequence that specifically hybridises to a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or an antisense sequence or RNA transcript thereof and instructions for carrying out the method of aspect 45, 47 or 48.

[0373] In embodiments of any of the aspects described herein, optionally, the PCSK9 is human PCSK9, eg, a mature, cleaved, autocatalysed or active PCSK9. In an example, the disease is a cardiovascular disease such as hyperlipidaemia.

[0374] In examples of the present invention, the ligand specifically binds to human PCSK9, eg, one or more of the rare PCSK9 variants disclosed herein (eg, one, two, three, more or all mature forms *f, c, r, p, m, e, h, aj* and *q*) and optionally also the *a* and/or a'form. For example, the ligand specifically binds to mature form fand/or cas well as form *a.*

[0375] Determination of such binding can be performed by any antibody binding test as known in the art, eg, by surface plasmon resonance. Binding to each such form is, for example, respectively with a Kd of at least 1mM, 100nM, 1nM, 100pM, 10pM or 1pM.

[0376] In an example, the ligand binds form a and a PCSK9 selected from the group consisting of forms *f, c, r, p, m, e, h, ajand q,* wherein the ligand binding to said selected form is with a Kd (determined by SPR) that is at least 60, 70, 80, 90 or 95% of the Kd for binding to form *a.* In an embodiment, both forms are mature forms. In an embodiment, both forms are pro-forms.

[0377] In an example, the ligand binds form a and form *f,* wherein the ligand binding to form *f* is with a Kd (determined by SPR) that is at least 60, 70, 80, 90 or 95% of the Kd for binding to form *a.* In an embodiment, both forms are mature forms. In an embodiment, both forms are pro-forms.

[0378] In an example, the ligand binds form a and form *c*, wherein the ligand binding to form *c* is with a Kd (determined by SPR) that is at least 60, 70, 80, 90 or 95% of the Kd for binding to form *a.* In an embodiment, both forms are mature forms. In an embodiment, both forms are pro-forms.

[0379] In an example, the ligand binds form a and form *r*, wherein the ligand binding to form *r* is with a Kd (determined by SPR) that is at least 60, 70, 80, 90 or 95% of the Kd for binding to form a. In an embodiment, both forms are mature forms. In an embodiment, both forms are pro-forms.

[0380] In an example, the ligand binds form a and form *p*, wherein the ligand binding to form *p* is with a Kd (determined by SPR) that is at least 60, 70, 80, 90 or 95% of the Kd for binding to form *a.* In an embodiment, both forms are mature forms. In an embodiment, both forms are pro-forms.

[0381] In an example, the ligand binds form a and form *m,* wherein the ligand binding to form *m* is with a Kd (determined by SPR) that is at least 60, 70, 80, 90 or 95% of the Kd for binding to form *a.* In an embodiment, both forms are mature forms. In an embodiment, both forms are pro-forms.

[0382] In an example, the ligand binds form a and form *e*, wherein the ligand binding to form *e* is with a Kd (determined by SPR) that is at least 60, 70, 80, 90 or 95% of the Kd for binding to form *a*. In an embodiment, both forms are mature forms. In an embodiment, both forms are pro-forms.

[0383] In an example, the ligand binds form *a* and form *h*, wherein the ligand binding to form *h* is with a Kd (determined by SPR) that is at least 60, 70, 80, 90 or 95% of the Kd for binding to form *a.* In an embodiment, both forms are mature forms. In an embodiment, both forms are pro-forms.

[0384] In an example, the ligand binds form *a* and form *aj,* wherein the ligand binding to form *aj* is with a Kd (determined by SPR) that is at least 60, 70, 80, 90 or 95% of the Kd for binding to form *a.* In an embodiment, both forms are mature forms. In an embodiment, both forms are pro-forms.

[0385] In an example, the ligand binds form *a* and form *q*, wherein the ligand binding to form *q* is with a Kd (determined by SPR) that is at least 60, 70, 80, 90 or 95% of the Kd for binding to form *a.* In an embodiment, both forms are mature forms. In an embodiment, both forms are pro-forms.

[0386] In examples of the present invention, the ligand neutralises human PCSK9, eg, one or more of the rare PCSK9 variants disclosed herein (eg, one, two, three, more or all mature forms *f, c, r, p, m, e, h, aj* and *q)* and optionally also the *a* and/or *a'*form. For example, the ligand neutralises mature form *f and/or c as well as form a.* Determination of neutralisation can be performed, for example, by any neutralisation assay method disclosed in US20120093818A1 (Amgen, Inc) or US20110065902A1 (Regeneron Pharmaceuticals, Inc). Ligands of the invention that bind or target PCSK9 are useful, for example, for therapeutic and prophylactic applications disclosed in US20120093818A1 and US20110065902A1, these specific disclosures being incorporated herein by reference in their entirety for use in the present invention and for possible inclusion in claims herein.

[0387] In embodiments where the ligand is used for therapeutic applications, an antigen binding protein can inhibit, interfere with or modulate one or more biological activities of a PCSK9 (eg, one or more of the rare variants disclosed herein and optionally also the *a* and/or *a*'form). In one embodiment, ligand binds specifically to human PCSK9 (eg, one or more of the rare variants disclosed herein and optionally also the *a* and/or *a*'form) and/or substantially inhibits binding of human PCSK9 (eg, said one or more of the rare variants disclosed herein and optionally also the *a* and/or *a*'form) to LDLR by at least 20%, eg, 20%-40%, 40-60%, 60-80%, 80-85%, or more (for example, by measuring binding in an *in vitro* competitive binding assay). In an example, the ligand is an antibody.

[0388] In an embodiment, the ligand has a Kd of less (binding more tightly) than 10^{-7}, 10^{-8}, 10^{-9}, 10^{-10}, 10^{-11}, 10^{-12}, 10^{-13} M for binding to one, two or more of the rare variants disclosed herein and optionally also the *a* and/or *a*'form. In an example, Kd is determined using SPR.

[0389] In an embodiment, the ligand has an IC50 for blocking the binding of LDLR to one or more of the rare PCSK9 variants disclosed herein (and optionally also the *a* and/or *a*'form) of less than 1 microM, 1000 nM to 100 nM, 100 nM to 10 nM, 10 nM to 1 nM, 1000 pM to 500 pM, 500 pM to 200 pM, less than 200 pM, 200 pM to 150 pM, 200 pM to 100 pM, 100 pM to 10 pM, 10 pM to 1 pM.

[0390] In an embodiment, the ligand has an IC50 for blocking the binding of LDLR to the *a* and/or *a*'form of PCSK9 that is no more than 1000, 100, 90, 80, 70, 60, 50, 40, 30, 20 or 10-fold more (ie, more inhibitory) than the IC50 for blocking the binding of LDLR to one or more of the rare PCSK9 variants disclosed herein (eg, one or more PCSK9 proteins comprising a sequence selected from SEQ ID NOs: 4 to 27). Additionally or alternatively, for example, the ligand has an IC50 for blocking the binding of LDLR to (i) the *a* and/or *a*'form of less than 1 microM, 1000 nM to 100 nM, 100 nM to 10 nM, 10 nM to 1 nM, 1000 pM to 500 pM, 500 pM to 200 pM, less than 200 pM, 200 pM to 150 pM, 200 pM to 100 pM, 100 pM to 10 pM, 10 pM to 1 pM, eg, in the range of 1mM to 1pM (eg, 1mM to 100pM; 10nM to 100pM; 1nM to 10pM; or 100pM to 1pM) and (ii) one or more PCSK9 proteins comprising a sequence selected from SEQ ID NOs: 4 to 27 of less than 1 microM, 1000 nM to 100 nM, 100 nM to 10 nM, 10 nM to 1 nM, 1000 pM to 500 pM, 500 pM to 200 pM, less than 200 pM, 200 pM to 150 pM, 200 pM to 100 pM, 100 pM to 10 pM, 10 pM to 1 pM, eg, in the range of 1mM to 1pM (eg, 1mM to 100pM; 10nM to 100pM; 1nM to 10pM; or 100pM to 1pM).

[0391] In an embodiment, the ligand binds to the *a* and/or *a*'form of PCSK9 with a binding affinity (Kd) that is greater than up to 10%, greater than up to 20%, greater than up to 40%, greater than up to 50%, greater than up to 55%, greater than up to 60%, greater than up to 65%, greater than up to 70%, greater than up to 75%, greater than up to 80%, greater than up to 85%, greater than up to 90%, greater than up to 95% or greater than up to 100% (ie, is double) relative to binding to a PCSK9 comprising a sequence selected from SEQ ID NOs: 4 to 27. Such binding measurements can be made using a variety of binding assays known in the art, eg, using surface plasmon resonance (SPR), such as by Biacore™ or using the ProteOn XPR36™ (Bio-Rad®), or using KinExA® (Sapidyne Instruments, Inc).

[0392] In one embodiment, the surface plasmon resonance (SPR) is carried out at 25°C. In another embodiment, the SPR is carried out at 37°C.

[0393] In one embodiment, the SPR is carried out at physiological pH, such as about pH7 or at pH7.6 (eg, using Hepes buffered saline at pH7.6 (also referred to as HBS-EP)).

[0394] In one embodiment, the SPR is carried out at a physiological salt level, eg, 150mM NaCl.

[0395] In one embodiment, the SPR is carried out at a detergent level of no greater than 0.05% by volume, eg, in the presence of P20 (polysorbate 20; eg, Tween-20TM) at 0.05% and EDTA at 3mM.

[0396] In one example, the SPR is carried out at 25°C or 37°C in a buffer at pH7.6, 150mM NaCl, 0.05% detergent (eg, P20) and 3mM EDTA. The buffer can contain 10mM Hepes. In one example, the SPR is carried out at 25°C or 37°C in HBS-EP. HBS-EP is available from Teknova Inc (California; catalogue number H8022).

[0397] In an example, the affinity of the ligand which is an antibody is determined using SPR by

1. Coupling anti-mouse (or other relevant vertebrate) IgG (eg, Biacore BR-1008-38) to a biosensor chip (eg, GLM chip) such as by primary amine coupling;
2. Exposing the anti-mouse IgG (vertebrate antibody) to a test IgG antibody to capture test antibody on the chip;
3. Passing the test antigen over the chip's capture surface at 1024nM, 256nM, 64nM, 16nM, 4nM with a 0nM (i.e. buffer alone); and
4. And determining the affinity of binding of test antibody to test antigen using surface plasmon resonance, eg, under an SPR condition discussed above (eg, at 25°C in physiological buffer). SPR can be carried out using any standard SPR apparatus, such as by BiacoreTM or using the ProteOn XPR36TM (Bio-Rad®).

[0398] Regeneration of the capture surface can be carried out with 10mM glycine at pH1.7. This removes the captured antibody and allows the surface to be used for another interaction. The binding data can be fitted to 1:1 model inherent using standard techniques, eg, using a model inherent to the ProteOn XPR36™ analysis software.

[0399] In an embodiment, assaying or testing of a ligand of the invention is carried out at or substantially at pH7 (eg, for *in vitro* tests and assays) and at or substantially at rtp.

[0400] One example of an IgG2 heavy chain constant domain of an anti-PCSK9 antibody of the present invention has the amino acid sequence as shown in SEQ ID NO: 154, FIG. **3**KK of US20120093818A1, which sequence is incorporated herein by reference.

[0401] One example of an IgG4 heavy chain constant domain of an anti-PCSK9 antibody of the present invention has the amino acid sequence as shown in SEQ ID NO: 155, FIG. **3**KK of US20120093818A1, which sequence and disclosure is incorporated herein by reference in its entirety.

[0402] One example of a kappa light chain constant domain of an anti-PCSK9 antibody has the amino acid sequence as shown in SEQ ID NO: 157, FIG. **3**KK of US20120093818A1, which sequence and disclosure is incorporated herein by reference in its entirety.

[0403] One example of a lambda light chain constant domain of an anti-PCSK9 antibody has the amino acid sequence as shown in SEQ ID NO: 156, FIG. **3**KK of US20120093818A1, which sequence and disclosure is incorporated herein by reference in its entirety.

[0404] In examples of the present invention, the ligand binds mature PCSK9, eg, a mature form of one or more of the rare variants disclosed herein and optionally also the **a** and/or *a'* form.

[0405] In examples of the present invention, the ligand binds the catalytic domain of PCSK9, eg, of a mature form of one or more of the rare variants disclosed herein and optionally also the *a* and/or *a*'form.

[0406] In examples of the present invention, the ligand binds the prodomain of PCSK9, eg, of a mature form of one or more of the rare variants disclosed herein and optionally also the *a* and/or *a*'form.

[0407] In some embodiments, the ligand binds to the V domain of PCSK9, eg, of a mature form of one or more of the rare variants disclosed herein and optionally also the *a* and/or *a'* form. In some embodiments, the ligand binds to the V domain of PCSK9 (eg, of a mature form of one or more of the rare variants disclosed herein and optionally also the *a* and/or *a*'form) and prevents (or reduces, eg, by at least 10%) PCSK9 from binding to LDLR. In some embodiments, the ligand binds to the V domain of PCSK9 (eg, of a mature form of one or more of the rare variants disclosed herein and optionally also the *a* and/or *a*'form), and while it does not prevent (or reduce) the binding of PCSK9 to LDLR, the ligand prevents or reduces (eg, by at least 10%) the adverse activities mediated through PCSK9 on LDLR.

[0408] In examples of the present invention, the ligand is or comprises a fully human antibody. In an example, the ligand comprises human variable regions or humanised variable regions.

[0409] In an example, the ligand of the invention specifically binds to an epitope of a human PCSK9 selected from the group consisting of forms *f, c, r, p, m, e, h, aj* and *q,* wherein the epitope comprises at least one amino acid that is not found in form *a.* For example, the amino acid is selected from the group consisting of 46L, 53V, 425S, 443T, 474V, 619P and 670G (numbering as used in SEQ ID NO:1). For example, the amino acid is selected from the group consisting of 425S, 443T, 474V, 619P and 670G (numbering as used in SEQ ID NO:1). For example, the amino acid is selected from the group consisting of 425S and 443T (numbering as used in SEQ ID NO:1). For example, the amino acid is selected from the group consisting of 474V, 619P and 670G (numbering as used in SEQ ID NO: 1). In an example, the PCSK9 form is the mature form. In an example, the PCSK9 form is the pro-form. In an example, the ligand also specifically binds to form *a* and/or *a:* In an embodiment, the ligand specifically binds to an epitope of form *f* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a.* In an embodiment, the ligand specifically binds to an epitope of form *c* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a.* In an embodiment, the ligand specifically binds to an epitope of form *r* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a.* In an embodiment, the ligand specifically binds to an epitope of form *p* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a.* In an embodiment, the ligand specifically binds to an epitope of form *m* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a.* In an embodiment, the ligand specifically binds to an epitope of form *e* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a.* In an embodiment, the ligand specifically binds to an epitope of form *h* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a.* In an embodiment, the ligand specifically binds to an epitope of form *aj* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a.* In an embodiment, the ligand specifically binds to an epitope of form *q* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a.*

[0410] In an embodiment, ligand binds specifically to the pro-domain of a human PCSK9 selected from the group consisting of forms *f, c, r, p, m, e, h, aj* and *q.* In an example, the ligand also specifically binds to the pro-domain of form a and/or *a'.* In an embodiment, the ligand specifically binds to the pro-domain of form *f* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a.* In an embodiment, the ligand specifically binds to the pro-domain of form *c* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a.* In an embodiment, the ligand specifically binds to the pro-domain of form *r* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a.* In an embodiment, the ligand specifically binds to the pro-domain of form *p* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a.* In an embodiment, the ligand specifically binds to the pro-domain of form *m* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a.* In an embodiment, the ligand specifically binds to the pro-domain of form *e* PCSK9, wherein the

epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the pro-domain of form *h* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the pro-domain of form *aj* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the pro-domain of form *q* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*.

[0411] In an embodiment, ligand binds specifically to the catalytic domain of a human PCSK9 selected from the group consisting of forms *f, c, r, p, m, e, h, aj* and *q*. In an example, the ligand also specifically binds to the catalytic domain of form a and/or *a'*. In an embodiment, the ligand specifically binds to the catalytic domain of form fPCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the catalytic domain of form *c* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the catalytic domain of form *r* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the catalytic domain of form *p* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the catalytic domain of form *m* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the catalytic domain of form *e* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the catalytic domain of form *h* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the catalytic domain of form *aj* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the catalytic domain of form *q* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*.

[0412] In an embodiment, ligand binds specifically to the C-terminal domain of a human PCSK9 selected from the group consisting of forms *f, c, r, p, m, e, h, aj* and *q*. In an example, the ligand also specifically binds to the C-terminal domain of form a and/or *a'*. In an embodiment, the ligand specifically binds to the C-terminal domain of form fPCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the C-terminal domain of form cPCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the C-terminal domain of form *r* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the C-terminal domain of form *p* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the C-terminal domain of form *m* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the C-terminal domain of form *e* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the C-terminal domain of form *h* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the C-terminal domain of form *aj* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the C-terminal domain of form *q* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*.

[0413] In an embodiment, ligand binds specifically to the substrate-binding groove of a human PCSK9 selected from the group consisting of forms *f, c, r, p, m, e, h, aj* and *q* (*see* Cunningham et al., Nat Struct Mol Biol. 2007 May;14(5):413-9. Epub 2007 Apr 15, "Structural and biophysical studies of PCSK9 and its mutants linked to familial hypercholesterolemia", incorporated herein in its entirety by reference). In an example, the ligand also specifically binds to the substrate-binding groove of form *a* and/or *a'*. In an embodiment, the ligand specifically binds to the Substrate-binding groove of form *f* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the Substrate-binding groove of form *c* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the Substrate-binding groove of form *r* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the Substrate-binding groove of form *p* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the Substrate-binding groove of form *m* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the Substrate-binding groove of form *e* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the Substrate-binding groove of form *h* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the Substrate-binding groove of form *aj* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*. In an embodiment, the ligand specifically binds to the Substrate-binding groove of form *q* PCSK9, wherein the epitope comprises at least one amino acid that is not found in form *a*.

[0414] Reference is made to US20120093818A1 (Amgen, Inc), the entire disclosure of which is incorporated herein by reference. This patent application discloses relevant ligands for use in the present invention, as well as examples and methods of producing and testing ligands that can be used with reference to the present invention.

[0415] In an example, the ligand is or comprises an antibody disclosed in Table 2 of US20120093818A1 (Amgen, Inc)

or is a PCSK9-binding derivative thereof.

[0416] In an embodiment, the PCSK9-binding ligand of the invention is selected from the antigen binding proteins disclosed in US20120093818A1 (Amgen, Inc), eg, in paragraphs [0009] to [0014] and [0058] to [0063] of US20120093818A1; all of these disclosures (including the sequences of such proteins) are incorporated herein by reference as though explicitly recited herein and for possible inclusion in one or more claims or for use in the present invention.

[0417] In this paragraph SEQ ID NOs are those as appearing in US20120093818A1 (Amgen, Inc) and these sequences are incorporated herein by reference as though explicitly recited herein and for possible inclusion in one or more claims or for use in the present invention. In some aspects, the ligand of the invention comprises an isolated antigen binding protein that binds PCSK9 comprising: A) one or more heavy chain complementary determining regions (CDRHs) selected from the group consisting of: (i) a CDRH1 from a CDRH1 in a sequence selected from the group consisting of SEQ ID NO: 74, 85, 71, 72, 67, 87, 58, 52, 51, 53, 48, 54, 55, 56, 49, 57, 50, 91, 64, 62, 89, 65, 79, 80, 76, 77, 78, 83, 69, 81, and 60; (ii) a CDRH2 from a CDRH2 in a sequence selected from the group consisting of SEQ ID NO: 74, 85, 71, 72, 67, 87, 58, 52, 51, 53, 48, 54, 55, 56, 49, 57, 50, 91, 64, 62, 89, 65, 79, 80, 76, 77, 78, 83, 69, 81, and 60; (iii) a CDRH3 from a CDRH3 in a sequence selected from the group consisting of SEQ ID NO: 74, 85, 71, 72, 67, 87, 58, 52, 51, 53, 48, 54, 55, 56, 49, 57, 50, 91, 64, 62, 89, 65, 79, 80, 76, 77, 78, 83, 69, 81, and 60; and (iv) a CDRH of (i), (ii), and (iii) that contains one or more amino acid substitutions, deletions or insertions of no more than 4 amino acids; B) one or more light chain complementary determining regions (CDRLs) selected from the group consisting of: (i) a CDRL1 from a CDRL1 in a sequence selected from the group consisting of SEQ ID NO: 5, 7, 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42, 44, and 46; (ii) a CDRL2 from a CDRL2 in a sequence selected from the group consisting of SEQ ID NO: 5, 7, 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42, 44, and 46; (iii) a CDRL3 from a CDRL3 in a sequence selected from the group consisting of SEQ ID NO: 5, 7, 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42, 44, and 46; and (iv) a CDRL of (i), (ii) and (iii) that contains one or more amino acid substitutions, deletions or insertions of no more than 4 amino acids; or C) one or more heavy chain CDRHs of A) and one or more light chain CDRLs of B). In some embodiments, the isolated antigen binding protein comprises at least one CDRH of A) and at least one CDRL of B). In some embodiments, the isolated antigen binding protein comprises at least two CDRH of A) and at least two CDRL of B). In some embodiments, the isolated antigen binding protein comprises said CDRH1, CDRH2, CDRH3, CDRL1, CDRL2 and CDRL3. In some embodiments, the CDRH of A) is selected from at least one of the group consisting of: (i) a CDRH1 amino acid sequence selected from the CDRH1 in a sequence selected from the group consisting of SEQ ID NO: 67, 79, 89, and 49; (ii) a CDRH2 amino acid sequence selected from the CDRH2 in a sequence selected from the group consisting of SEQ ID NO: 67, 79, 89, and 49; (iii) a CDRH3 amino acid sequence selected from the CDRH3 in a sequence selected from the group consisting of SEQ ID NO: 67, 79, 89, and 49; and (iv) a CDRH of (i), (ii) and (iii) that contains one or more amino acid substitutions, deletions or insertions of no more than 2 amino acids. In addition, the CDRL of B) is selected from at least one of the group consisting of: (i) a CDRL1 amino acid sequence selected from the CDRL1 in a sequence selected from the group consisting of SEQ ID NO: 12, 35, 32, and 23; (ii) a CDRL2 amino acid sequence selected from the CDRL2 in a sequence selected from the group consisting of SEQ ID NO: 12, 35, 32, and 23; (iii) a CDRL3 amino acid sequence selected from the CDRL3 in a sequence selected from the group consisting of SEQ ID NO: 12, 35, 32, and 23; and (iv) a CDRL of (i), (ii) and (iii) that contains one or more amino acid substitutions, deletions or insertions of no more than 2 amino acids; or C) one or more heavy chain CDRHs of A) and one or more light chain CDRLs of B. In some embodiments, the CDRH of A) is selected from at least one of the group consisting of: (i) a CDRH1 amino acid sequence of the CDRH1 amino acid sequence in SEQ ID NO: 67; (ii) a CDRH2 amino acid sequence of the CDRH2 amino acid sequence in SEQ ID NO: 67; (iii) a CDRH3 amino acid sequence of the CDRH3 amino acid sequence in SEQ ID NO: 67; and (iv) a CDRH of (i), (ii) and (iii) that contains one or more amino acid substitutions, deletions or insertions of no more than 2 amino acids; said CDRL of B) is selected from at least one of the group consisting of: (i) a CDRL1 amino acid sequence of the CDRL1 amino acid sequence in SEQ ID NO: 12; (ii) a CDRL2 amino acid sequence of the CDRL2 amino acid sequence in SEQ ID NO: 12; (iii) a CDRL3 amino acid sequence of the CDRL3 amino acid sequence in SEQ ID NO: 12; and (iv) a CDRL of (i), (ii) and (iii) that contains one or more amino acid substitutions, deletions or insertions of no more than 2 amino acids; or C) one or more heavy chain CDRHs of A) and one or more light chain CDRLs of B). In some embodiments, the antigen binding protein comprises A) a CDRH1 of the CDRH1 sequence in SEQ ID NO: 67, a CDRH2 of the CDRH2 sequence in SEQ ID NO: 67, and a CDRH3 of the CDRH3 sequence in SEQ ID NO: 67, and B) a CDRL1 of the CDRL1 sequence in SEQ ID NO: 12, a CDRL2 of the CDRL2 sequence in SEQ ID NO: 12, and a CDRL3 of the CDRL3 sequence in SEQ ID NO: 12. In some embodiments, the antigen binding protein comprises a heavy chain variable region (VH) having at least 80% sequence identity with an amino acid sequence selected from the group consisting of SEQ ID NO: 74, 85, 71, 72, 67, 87, 58, 52, 51, 53, 48, 54, 55, 56, 49, 57, 50, 91, 64, 62, 89, 65, 79, 80, 76, 77, 78, 83, 69, 81, and 60, and/or a light chain variable region (VL) having at least 80% sequence identity with an amino acid sequence selected from the group consisting of SEQ ID NO: 5, 7, 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42,

44, and 46. In some embodiments, the VH has at least 90% sequence identity with an amino acid sequence selected from the group consisting of SEQ ID NO: 74, 85, 71, 72, 67, 87, 58, 52, 51, 53, 48, 54, 55, 56, 49, 57, 50, 91, 64, 62, 89, 65, 79, 80, 76, 77, 78, 83, 69, 81, and 60, and/or the VL has at least 90% sequence identity with an amino acid sequence selected from the group consisting of SEQ ID NO: 5, 7, 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42, 44, and 46. In some embodiments, the VH is selected from the group consisting of SEQ ID NO: 74, 85, 71, 72, 67, 87, 58, 52, 51, 53, 48, 54, 55, 56, 49, 57, 50, 91, 64, 62, 89, 65, 79, 80, 76, 77, 78, 83, 69, 81, and 60, and/or the VL is selected from the group consisting of SEQ ID NO: 5, 7, 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42, 44, and 46.

[0418] In an example of any aspect of the invention, the PCSK9-targeting or binding ligand comprises or consists of AMG145 or 31H4, 16F12, 11F1, 8A3 or 21B12 disclosed in US20120093818A1 (Amgen, Inc) or an antibody comprising the variable domains of AMG145, 31H4, 16F12, 11F1, 8A3 or 21B12, the disclosures of which (including sequences) are incorporated herein by reference as though explicitly recited herein and for possible inclusion in one or more claims or for use in the present invention. Preferably, the PCSK9-targeting or binding ligand comprises or consists of AMG145.

[0419] In an example, the AMG145 or other ligand of the invention is glycosylated, eg, has human glycosylation (eg, produced by a CHO, Cos or Hek293 cell). In an example, the ligand of the invention is produced in CHO.

[0420] Reference is made to US20110065902A1 (Regeneron Pharmaceuticals, Inc), the entire disclosure of which is incorporated herein by reference. This patent application discloses relevant ligands for use in the present invention, as well as examples and methods of producing and testing ligands and determining medical efficacy that can be used with reference to the present invention.

[0421] Reference is made to the following PCT applications, the entire disclosures of which are incorporated herein by reference. These disclose relevant ligands for use in the present invention, as well as examples and methods of producing and testing ligands and determining medical efficacy that can be used with reference to the present invention.

WO2008057457
WO2008057458
WO2008057459
WO2008063382
WO2008133647
WO2009100297
WO2009100318
WO2011037791
WO2011053759
WO2011053783
WO2008125623
WO2011072263
WO2009055783
WO2010029513
WO2011111007
WO2010077854

Antibody ligands to PCSK9 are described in, for example, WO 2008/057457, WO 2008/057458, WO 2008/057459, WO 2008/063382, WO 2008/125623, and US 2008/0008697.

[0422] In an example, the ligand is or comprises an antibody disclosed in the Examples of US20110065902A1 (eg, 316P or 300N) or is a PCSK9-binding derivative thereof. All of these disclosures (including the sequences of such proteins and corresponding nucleotide sequences) are incorporated herein by reference as though explicitly recited herein and for possible inclusion in one or more claims or for use in the present invention. In an embodiment, the ligand is or comprises the variable domains of antibody 316P or 300N disclosed in US20110065902A1 or is (or comprises) such antibody or a PCSK9-binding derivative thereof. The foregoing reference is incorporated by reference herein in its entirety.

[0423] In an embodiment, the ligand is or comprises the variable domains of antibody alirocumab or SAR236553/REGN727 (Sanofi Aventis/Regeneron) or is (or comprises) such antibody or a PCSK9-binding derivative thereof. In an example, the antibody is glycosylated, eg, has human glycosylation (eg, produced by a CHO, Cos or Hek293 cell). Preferably, the ligand is alirocumab or SAR236553/REGN727.

[0424] In an embodiment, the ligand is or comprises the variable domains of antibody evolocumab or or is (or comprises) such antibody or a PCSK9-binding derivative thereof. In an example, the antibody is glycosylated, eg, has human glycosylation (eg, produced by a CHO, Cos or Hek293 cell). Preferably, the ligand is evolocumab.

[0425] In an embodiment, the ligand is selected from evolocumab, 1D05-IgG2 (Merck & Co.), ALN-PCS02 (Alnylam), RN316 (Pfizer-Rinat) and alirocumab.

[0426] In an embodiment, the ligand is selected from the following (sequences and definitions as per US2011/0065902, incorporated herein by reference in its entirety):-

1. An antibody or antigen-binding fragment thereof which specifically binds hPCSK9, wherein the antibody or antigen-binding fragment comprises the heavy and light chain CDRs of a HCVR/LCVR amino acid sequence pair having SEQ ID NOs: 218/226.
2. The antibody or antigen-binding fragment of concept 1 comprising heavy and light chain CDR amino acid sequences having SEQ ID NOs: 220, 222, 224, 228, 230 and 232.
3. The antibody or antigen-binding fragment of concept 2 comprising an HCVR having the amino acid sequence of SEQ ID NO: 218 and an LCVR having the amino acid sequence of SEQ ID NO: 226.
4. An antibody or antigen-binding fragment thereof which binds to the same epitope on hPCSK9 as an antibody comprising heavy and light chain CDR amino acid sequences having SEQ ID NOs: 220, 222, 224, 228, 230 and 232.
5. An antibody or antigen-binding fragment thereof which competes for binding to hPCSK9 with an antibody comprising heavy and light chain CDR amino acid sequences having SEQ ID NOs: 220, 222, 224, 228, 230 and 232.

[0427] In an embodiment, the ligand is selected from the following (sequences and definitions as per US2012/0093818, incorporated herein by reference herein in its entirety):-

1. An isolated neutralizing antigen binding protein that binds to a PCSK9 protein comprising the amino acid sequence of SEQ ID NO: 1, wherein the neutralizing antigen binding protein decreases the LDLR lowering effect of PCSK9 on LDLR, wherein the antigen binding protein comprises a light chain comprising an amino acid sequence of SEQ ID NO: 46, and wherein the antigen binding protein comprises a heavy chain comprising an amino acid sequence of SEQ ID NO: 60.
2. The isolated neutralizing antigen binding protein of concept 2, wherein the antigen binding protein is a LDLR non-competitive neutralizing antigen binding protein.
3. The isolated neutralizing antigen binding protein of concept 2, wherein the antigen binding protein is a LDLR competitive neutralizing antigen binding protein.
4. An antigen binding protein that selectively binds to PCSK9, wherein said antigen binding protein binds to PCSK9 with a Kd that is less than 100 pM.
5. An antigen binding protein that binds to a PCSK 9 protein of SEQ ID NO: 303 in a first manner, wherein the antigen binding protein binds to a variant of PCSK9 in a second manner, wherein said PCSK9 variant has at least one point mutation at a position selected from the group consisting of: 207, 208, 185, 181, 439, 513, 538, 539, 132, 351, 390, 413, 582, 162, 164, 167, 123, 129, 311, 313, 337, 519, 521, and 554 of SEQ ID NO: 303, wherein the first manner comprises a first EC50, a first Bmax, or a first EC50 and a first Bmax, wherein the second manner comprises a second EC50, a second Bmax, or a second EC50 and a second Bmax, and wherein a value for the first manner is different from a value for the second manner, and wherein the antigen binding protein comprises a light chain comprising an amino acid sequence of SEQ ID NO: 46, and wherein the antigen binding protein comprises a heavy chain comprising an amino acid sequence of SEQ ID NO: 60.
6. The antigen binding protein of concept 6, wherein the first manner comprises a first Bmax, wherein the second manner comprises a second Bmax that is different from the first Bmax, and wherein said PCSK9 variant has at least one point mutation selected from the group consisting of: D162R, R164E, E167R, S123R, E129R, A311R, D313R, D337R, R519E, H521R, and Q554R.
7. The antigen binding protein of concept 6, wherein the antigen binding protein binds to PCSK9 at a location that overlaps with a location that LDLR binds to PCSK9.
8. A method of making an antigen binding protein that binds to a PCSK9 protein comprising the amino acid sequence of SEQ ID NO: 1, wherein the antigen binding protein decreases the LDLR lowering effect of PCSK9 on LDLR, said method comprising: providing a host cell comprising a nucleic acid sequence that encodes the antigen binding protein; andmaintaining the host cell under conditions in which the antigen binding protein is expressed, wherein the antigen binding protein comprises a light chain comprising an amino acid sequence of SEQ ID NO: 46, and wherein the antigen binding protein comprises a heavy chain comprising an amino acid sequence of SEQ ID NO: 60.
9. A method for treating or preventing a condition associated with elevated serum cholesterol levels in a subject, said method comprising administering to a subject in need thereof an effective amount of an isolated neutralizing antigen binding protein simultaneously or sequentially with an agent that elevates the availability of LDLR protein, wherein the isolated antigen binding protein binds to a PCSK9 protein comprising the amino acid sequence of SEQ ID NO: 1, wherein the neutralizing antigen binding protein decreases the LDLR lowering effect of PCSK9 on LDLR, wherein the antigen binding protein comprises a light chain comprising an amino acid sequence of SEQ ID NO: 46, and wherein the antigen binding protein comprises a heavy chain comprising an amino acid sequence of SEQ ID NO: 60.

10. The method of concept 10, wherein the agent that elevates the availability of LDLR protein comprises a statin.
11. An antigen binding protein that binds to PCSK9, wherein when the antigen binding protein is bound to PCSK9, the antibody is positioned 8 angstroms or less from at least one of the following residues of PCSK9: S153, S188, 1189, Q190, S191, D192, R194, E197, G198, R199, V200, D224, R237, D238, K243, S373, D374, S376, T377, F379, 1154, T187, H193, E195, 1196, M201, V202, C223, T228, S235, G236, A239, G244, M247, 1369, S372, C375, or C378, wherein the antigen binding protein comprises a light chain comprising an amino acid sequence of SEQ ID NO: 46, and wherein the antigen binding protein comprises a heavy chain comprising an amino acid sequence of SEQ ID NO: 60.

[0428] The ligand can be used for the treatment, therapy, prophylaxis and/or diagnosis of one or more diseases or conditions or susceptibility thereto, wherein such diseases or conditions comprise those disclosed in US20120093818A1 (Amgen, Inc) and US20110065902A1 (Regeneron Pharmaceuticals, Inc), eg, a disease or condition disclosed in paragraphs [0375] to [0383] of US20120093818A1, which disclosure is incorporated herein by reference in its entirety for inclusion in one more claims herein.

[0429] The ligand can be administered to a human characterised as described in US20120093818A1 (Amgen, Inc) or US20110065902A1; each of which is incorporated by reference herein in its entirety.

[0430] The ligand can be administered in a form or combination disclosed in US20120093818A1 (Amgen, Inc) or US20110065902A1, which disclosure is incorporated herein by reference. For example, the ligand with a drug, excipient, diluent or carrier as described in US20120093818A1 (Amgen, Inc) or US20110065902A1 (eg, as disclose in paragraphs [0384] to [0412] of US20120093818A1), which disclosure is incorporated herein by reference, and the present invention also relates to the corresponding pharmaceutical compositions comprising the combination of a ligand of the invention and such a further agent. Each of the foregoing references is incorporated by reference herein in its entirety.

[0431] The ligand can be used in a method of diagnosis as set out in US20120093818A1 (Amgen, Inc) or US20110065902A1, eg, in paragraphs [0413] to [0415] of US20120093818A1 which disclosure is incorporated herein by reference. Each of the foregoing references is incorporated by reference herein in its entirety.

Diagnostic Applications

[0432] In some embodiments, the ligand of the invention is a diagnostic tool. The ligand can be used to assay the amount of PCSK9 present in a sample and/or subject. As will be appreciated by one of skill in the art, such ligands need not be neutralizing ligands. In some embodiments, the diagnostic ligand is not a neutralizing ligand. In some embodiments, the diagnostic ligand binds to a different epitope than a neutralizing ligand binds to. In some embodiments, the two ligands do not compete with one another.

[0433] In some embodiments, the ligands of the invention are used or provided in an assay kit and/or method for the detection of PCSK9 in mammalian tissues or cells in order to screen/diagnose for a disease or disorder associated with changes in levels of PCSK9. The kit comprises a ligand that binds PCSK9 and means for indicating the binding of the ligand with PCSK9, if present, and optionally PCSK9 protein levels. Various means for indicating the presence of a ligand can be used. For example, fluorophores, other molecular probes, or enzymes can be linked to the ligand and the presence of the ligand can be observed in a variety of ways. The method for screening for such disorders can involve the use of the kit, or simply the use of one of the disclosed ligands and the determination of whether the ligand binds to PCSK9 in a sample. As will be appreciated by one of skill in the art, high or elevated levels of PCSK9 will result in larger amounts of the ligand binding to PCSK9 in the sample. Thus, degree of ligand binding can be used to determine how much PCSK9 is in a sample. Subjects or samples with an amount of PCSK9 that is greater than a predetermined amount (e.g., an amount or range that a person without a PCSK9 related disorder would have) can be characterized as having a PCSK9 mediated disorder. In some embodiments, the invention provides a method wherein the ligand is administered to a subject taking a statin, in order to determine if the statin has increased the amount of PCSK9 in the subject.

[0434] In some embodiments, the ligand is a non-neutralizing ligand and is used to determine the amount of PCSK9 in a subject receiving an ABP and/or statin treatment.

[0435] In some embodiments, the ligand of the invention can specifically bind human PCSK9 (eg, one, two or more rare variant forms disclosed herein) and is characterized by at least one of: (i) capable of reducing serum total cholesterol at least about 25-35% and sustaining the reduction over at least a 24 day period relative to a predose level; (ii) capable of reducing serum LDL cholesterol at least about 65-80% and sustaining the reduction over at least a 24 day period relative to a predose level; (iii) capable of reducing serum LDL cholesterol at least about 40-70% and sustaining the reduction over at least a 60 or 90 day period relative to a predose level; (iv) capable of reducing serum triglyceride at least about 25-40% relative to predose level; (v) does not reduce serum HDL cholesterol or reduces serum HDL cholesterol no more than 5% relative to predose level. In some embodiments, an isolated nucleic acid molecule is provided and it encodes the ligand. In some embodiments an expression vector is provided and comprises the nucleic acid molecule. In some embodiments, a pharmaceutical composition is provided and it can comprise the ligand and a pharmaceutically

acceptable carrier. In some embodiments, a method is provided for treating a disease or condition which is ameliorated, improved, inhibited or prevented with a PCSK9 antagonist ligand of the invention. The method can comprise administering a therapeutic amount of the pharmaceutical composition or ligand to a subject in need thereof. In some embodiments, the subject is a human subject suffering from hypercholesterolemia, hyperlipidemia, indicated for LDL apheresis, identified as heterozygous for Familial Hypercholesterolemia, statin intolerant. statin uncontrolled, at risk for developing hypercholesterolemia, dyslipidemia, cholestatic liver disease, nephrotic syndrome, hypothyroidism, obesity, atherosclerosis and cardiovascular diseases. In some embodiments, a method of providing a treatment or therapy is provided to a subject. In some embodiments, the method comprises reducing serum cholesterol at least about 40-70% over at least 60 to 90 days. In some embodiments, a method of receiving treatment or therapy is provided, the method can comprise receiving a ligand thereof at a frequency of once every 60 to 90 days.

[0436] In one aspect, the invention provides a ligand of the invention which is or comprises an human antibody or antigen-binding fragment of a human antibody that specifically binds and inhibits human proprotein convertase subtilisin/kexin type 9 (hPCSK9, eg, one, two or more rare variant forms disclosed herein and optionally form a and/or form a), characterized by the ability to reduce serum LDL cholesterol in a human by 40-80% over a 24, 60 or 90 day period relative to predose levels, with little or no reduction in serum HDL cholesterol and/or with little or no measurable effect on liver function, as determined by ALT and AST measurements.

[0437] In one embodiment, the ligand of the invention comprises an antibody or antigen-binding fragment of an antibody that specifically binds hPCSK9 and is characterized by at least one of:

(i) capable of reducing serum total cholesterol at least about 25-35% and sustaining the reduction over at least a 24 day period relative to a predose level, preferably the reduction in serum total cholesterol is at least about 30-40%;
(ii) capable of reducing serum LDL cholesterol at least about 65-80% and sustaining the reduction over at least a 24 day period relative to a predose level;
(iii) capable of reducing serum triglyceride at least about 25-40% relative to predose level;
(iv) does not reduce serum HDL cholesterol or reduces serum HDL cholesterol no more than 5% relative to predose level. See US2011/0065902 for definitions of these terms and optional features, the disclosure of which are incorporated herein by reference in its entirety.

[0438] In one embodiment, the invention comprises an antibody or antigen-binding fragment of an antibody that specifically binds hPCSK9 and is characterized by at least one of:

(i) capable of reducing serum LDL cholesterol at least about 40-70% and sustaining the reduction over at least a 60 or 90 day period relative to a predose level;
(ii) capable of reducing serum triglyceride at least about 25-40% relative to predose level;
(iii) does not reduce serum HDL cholesterol or reduces serum HDL cholesterol no more than 5% relative to predose level.

[0439] In one embodiment, the antibody or antigen-binding fragment is characterized as exhibiting an enhanced binding affinity (KD) for hPCSK9 at pH 5.5 relative to the KD at pH 7.4, as measured by plasmon surface resonance. In a specific embodiment, the antibody or fragment thereof exhibits at least a 20-fold, at least a 40-fold or at least a 50-fold enhanced affinity for PCSK9 at an acidic pH relative to a neutral pH, as measured by surface plasmon resonance.

[0440] In one embodiment, the antibody or antigen-binding fragment is characterized as not exhibiting an enhanced binding affinity for PCSK9 at an acidic pH relative to a neutral pH, as measured by surface plasmon resonance. In a specific embodiment, the antibody or fragment thereof exhibits a decreased binding affinity at an acidic pH.

[0441] In another embodiment, the antibody or antigen-binding fragment binds human, human GOF mutation D374Y, cynomolgus monkey, rhesus monkey, mouse, rat and hamster PCSK9.

[0442] In one embodiment, the antibody or antigen-binding fragment binds human and monkey PCSK9, but does not bind mouse, rat or hamster PCSK9.

[0443] In one embodiment, the invention comprises an antibody or antigen-binding fragment of an antibody comprising one or more of a heavy chain variable region (HCVR), light chain variable region (LCVR), HCDR1, HCDR2, HCDR3 disclosed in any of paragraphs [023]-[037] of US2011/0065902, the disclosure of which is incorporated herein by reference in its entirety.

[0444] In a related embodiment, the invention comprises an antibody or antigen-binding fragment of an antibody which specifically binds hPCSK9, wherein the antibody or fragment comprises heavy and light chain CDR domains contained within heavy and light chain sequence pairs selected from the group consisting of SEQ ID NO (using the sequence numbering in US2011/0065902): 2/10, 18/20, 22/24, 26/34, 42/44, 46/48, 50/58, 66/68, 70/72, 74/82, 90/92, 94/96, 98/106, 114/116, 118/120, 122/130, 138/140, 142/144, 146/154, 162/164, 166/168, 170/178, 186/188, 190/192, 194/202, 210/212, 214/216, 218/226, 234/236, 238/240, 242/250, 258/260, 262/264, 266/274, 282/284, 286/288, 290/298,

306/308, 310/312, 314/322, 330/332, 334/336, 338/346, 354/356, 358/360, 362/370, 378/380, 382/384, 386/394, 402/404, 406/408, 410/418, 426/428, 430/432, 434/442, 450/452, 454/456, 458/466, 474/476, 478/480, 482/490, 498/500, 502/504, 506/514, 522/524, 526/528, 530/538, 546/548, 550/552, 554/562, 570/572, 574/576, 578/586, 594/596, 598/600, 602/610, 618/620, 622/624, 626/634, 642/644, 646/648, 650/658, 666/668, 670/672, 674/682, 690/692, 694/696, 698/706, 714/716, 718/720, 722/730, 738/740 and 742/744. In one embodiment, the CDR sequences are contained within HCVR and LCVR selected from the amino acid sequence pairs of SEQ ID NO: 50/58, 66/68, 70/72, 74/82, 90/92, 94/96, 122/130, 138/140, 142/144, 218/226, 234/236, 238/240, 242/250, 258/260, 262/264, 314/322, 330/332 and 334/336. In more specific embodiments, the CDR sequences are comprised within HCVR/LCVR sequences selected from SEQ ID NO: 90/92 or 218/226. Each of the foregoing references is incorporated by reference herein in its entirety.

[0445] In an example, the invention features a pharmaceutical composition comprising a ligand of the invention, wherein the ligand comprises or consists of a recombinant human antibody or fragment thereof which specifically binds hPCSK9 and a pharmaceutically acceptable carrier. In one embodiment, the invention features a composition which is a combination of a ligand of the invention (eg, an antibody or antigen-binding fragment of an antibody), and a second therapeutic agent. The second therapeutic agent may be any agent that is advantageously combined with the ligand of the invention, for example, an agent capable of inducing a cellular depletion of cholesterol synthesis by inhibiting 3-hydroxy-3-methylglutaryl (HMG)-coenzyme A (CoA) reductase, such as, for example, cerovastatin, atorvastatin, simvastatin, pitavastin, rosuvastatin, fluvastatin, lovastatin, pravastatin, etc; capable of inhibiting cholesterol uptake and or bile acid re-absorption; capable of increasing lipoprotein catabolism (such as niacin); and/or activators of the LXR transcription factor that plays a role in cholesterol elimination such as 22-hydroxycholesterol.

[0446] In an example, the invention provides a method for inhibiting hPCSK9 activity using the anti-PCSK9 ligand of the invention (eg, an antibody or antigen-binding portion of the antibody of the invention), wherein the therapeutic methods comprise administering a therapeutically effective amount of a pharmaceutical composition comprising an antibody or antigen-binding fragment of an antibody of the invention. The disorder treated is any disease or condition which is improved, ameliorated, inhibited or prevented by removal, inhibition or reduction of PCSK9 activity. Specific populations treatable by the therapeutic methods of the invention include subjects indicated for LDL apheresis, subjects with PCSK9-activating mutations (gain of function mutations, "GOF"), subjects with heterozygous Familial Hypercholesterolemia (heFH); subjects with primary hypercholesterolemia who are statin intolerant or statin uncontrolled; and subjects at risk for developing hypercholesterolemia who may be preventably treated. Other indications include dyslipidemia associated with secondary causes such as Type 2 diabetes mellitus, cholestatic liver diseases (primary biliary cirrhosis), nephrotic syndrome, hypothyroidism, obesity; and the prevention and treatment of atherosclerosis and cardiovascular diseases.

[0447] In specific embodiments of the method of the invention, the ligand of the invention (eg, anti-hPCSK9 antibody or antibody fragment of the invention) is useful to reduce elevated total cholesterol, non-HDL cholesterol, LDL cholesterol, and/or apolipoprotein B (apolipoprotein B100).

[0448] The ligand (eg, antibody or antigen-binding fragment) of the invention may be used alone or in combination with a second agent, for example, an HMG-CoA reductase inhibitor and/or another lipid lowering drug.

[0449] The term "isolated" with reference to a ligand, antibody or protein, for example in any aspect, configuration, example or emodiment, means that a subject ligand, antibody, protein etc (1) is free of at least some other proteins with which it would normally be found, (2) is essentially free of other proteins from the same source, e.g., from the same species, (3) is expressed by a cell from a different species, (4) has been separated from at least about 50 percent of polynucleotides, lipids, carbohydrates, or other materials with which it is associated in nature, (5) is operably associated (by covalent or noncovalent interaction) with a polypeptide with which it is not associated in nature, or (6) does not occur in nature. Typically, an "isolated" ligand, antibody, protein etc constitutes at least about 5%, at least about 10%, at least about 25%, or at least about 50% of a given sample. Genomic DNA, cDNA, mRNA or other RNA, of synthetic origin, or any combination thereof can encode such an isolated ligand, antibody protein etc. Preferably, the isolated ligand, antibody protein etc is substantially free from proteins or polypeptides or other contaminants that are found in its natural environment that would interfere with its therapeutic, diagnostic, prophylactic, research or other use.

[0450] For example, an "isolated" antibody is one that has been identified, separated and/or recovered from a component of its production environment (eg, naturally or recombinantly). Preferably, the isolated polypeptide is free of association with all other components from its production environment, eg, so that the antibody has been isolated to an FDA-approvable or approved standard. Contaminant components of its production environment, such as that resulting from recombinant transfected cells, are materials that would typically interfere with research, diagnostic or therapeutic uses for the antibody, and may include enzymes, hormones, and other proteinaceous or non-proteinaceous solutes. In preferred embodiments, the polypeptide will be purified: (1) to greater than 95% by weight of antibody as determined by, for example, the Lowry method, and in some embodiments, to greater than 99% by weight; (2) to a degree sufficient to obtain at least 15 residues of N-terminal or internal amino acid sequence by use of a spinning cup sequenator, or (3) to homogeneity by SDS-PAGE under non-reducing or reducing conditions using Coomassie blue or, preferably, silver stain. Isolated antibody includes the antibody in situ within recombinant cells since at least one component of the

antibody's natural environment will not be present. Ordinarily, however, an isolated polypeptide or antibody will be prepared by at least one purification step.

Immunoconjugates

[0451] The invention encompasses the ligand (eg, antibody) conjugated to a therapeutic moiety ("immunoconjugate"), such as a cytotoxin, a chemotherapeutic drug, an immunosuppressant or a radioisotope. Cytotoxin agents include any agent that is detrimental to cells. Examples of suitable cytotoxin agents and chemotherapeutic agents for forming immunoconjugates are known in the art, see for example, WO 05/103081, which is incorporated by reference herein in its entirety.

Bispecifics

[0452] The antibodies of the present invention may be monospecific, bispecific, or multispecific. Multispecific mAbs may be specific for different epitopes of one target polypeptide or may contain antigen-binding domains specific for more than one target polypeptide. See, e.g., Tutt et al. (1991) J. Immunol. 147:60-69. The human anti-PCSK9 (eg, anti-PCSK9) mAbs can be linked to or co-expressed with another functional molecule, e.g., another peptide or protein. For example, an antibody or fragment thereof can be functionally linked (e.g., by chemical coupling, genetic fusion, noncovalent association or otherwise) to one or more other molecular entities, such as another antibody or antibody fragment, to produce a bispecific or a multispecific antibody with a second binding specificity.

[0453] An exemplary bi-specific antibody format that can be used in the context of the present invention involves the use of a first immunoglobulin (Ig) CH3 domain and a second Ig CH3 domain, wherein the first and second Ig CH3 domains differ from one another by at least one amino acid, and wherein at least one amino acid difference reduces binding of the bispecific antibody to Protein A as compared to a bi-specific antibody lacking the amino acid difference. In one embodiment, the first Ig CH3 domain binds Protein A and the second Ig CH3 domain contains a mutation that reduces or abolishes Protein A binding such as an H95R modification (by IMGT exon numbering; H435R by EU numbering). The second CH3 may further comprise a Y96F modification (by IMGT; Y436F by EU). Further modifications that may be found within the second CH3 include: D16E, L18M, N44S, K52N, V57M, and V821 (by IMGT; D356E, L358M, N384S, K392N, V397M, and V422I by EU) in the case of IgG1 antibodies; N44S, K52N, and V82I (IMGT; N384S, K392N, and V422I by EU) in the case of IgG2 antibodies; and Q15R, N44S, K52N, V57M, R69K, E79Q, and V82I (by IMGT; Q355R, N3845, K392N, V397M, R409K, E419Q, and V422I by EU) in the case of IgG4 antibodies. Variations on the bi-specific antibody format described above are contemplated within the scope of the present invention.

Treatment Population

[0454] The invention provides therapeutic methods for treating a human patient in need of a composition or ligand of the invention. While modifications in lifestyle and conventional drug treatment are often successful in reducing cholesterol levels, not all patients are able to achieve the recommended target cholesterol levels with such approaches. Various conditions, such as familial hypercholesterolemia (FH), appear to be resistant to lowering of LDL-C levels in spite of aggressive use of conventional therapy. Homozygous and heterozygous familial hypercholesterolemia (hoFH, heFH) is a condition associated with premature atherosclerotic vascular disease. However, patients diagnosed with hoFH are largely unresponsive to conventional drug therapy and have limited treatment options. Specifically, treatment with statins, which reduce LDL-C by inhibiting cholesterol synthesis and upregulating the hepatic LDL receptor, may have little effect in patients whose LDL receptors are non-existent or defective. A mean LDL-C reduction of only less than about 20% has been recently reported in patients with genotype-confirmed hoFH treated with the maximal dose of statins. The addition of ezetimibe 10 mg/day to this regimen resulted in a total reduction of LDL-C levels of 27%, which is still far from optimal. Likewise, many patients are statin non-responsive, poorly controlled with statin therapy, or cannot tolerate statin therapy; in general, these patients are unable to achieve cholesterol control with alternative treatments. There is a large unmet medical need for new treatments that can address the short-comings of current treatment options.

[0455] Specific populations treatable by the therapeutic methods of the invention include patients indicated for LDL apheresis, subjects with PCSK9-activating (GOF) mutations, heterozygous Familial Hypercholesterolemia (heFH); subjects with primary hypercholesterolemia who are statin intolerant or statin uncontrolled; and subjects at risk for developing hypercholesterolemia who may be preventably treated.

Therapeutic Administration and Formulations

[0456] The invention provides therapeutic compositions comprising the anti-PCSK9 ligands, antibodies or antigen-binding fragments thereof of the present invention. The administration of therapeutic compositions in accordance with

the invention will be administered with suitable carriers, excipients, and other agents that are incorporated into formulations to provide improved transfer, delivery, tolerance, and the like. A multitude of appropriate formulations can be found in the formulary known to all pharmaceutical chemists: Remington's Pharmaceutical Sciences, Mack Publishing Company, Easton, Pa. These formulations include, for example, powders, pastes, ointments, jellies, waxes, oils, lipids, lipid (cationic or anionic) containing vesicles (such as LIPOFECTINT™), DNA conjugates, anhydrous absorption pastes, oil-in-water and water-in-oil emulsions, emulsions carbowax (polyethylene glycols of various molecular weights), semi-solid gels, and semi-solid mixtures containing carbowax. See also Powell et al. "Compendium of excipients for parenteral formulations" PDA (1998) J Pharm Sci Technol 52:238-311.

[0457] The dose may vary depending upon the age and the size of a subject to be administered, target disease, conditions, route of administration, and the like. When the ligand, eg, antibody, of the present invention is used for treating various conditions and diseases associated with PCSK9, including hypercholesterolemia, disorders associated with LDL and apolipoprotein B, and lipid metabolism disorders, and the like, in an adult patient, it is advantageous to intravenously administer the ligand or antibody of the present invention normally at a single dose of about 0.01 to about 20 mg/kg body weight, more preferably about 0.02 to about 7, about 0.03 to about 5, or about 0.05 to about 3 mg/kg body weight. Depending on the severity of the condition, the frequency and the duration of the treatment can be adjusted.

[0458] Various delivery systems are known and can be used to administer the pharmaceutical composition of the invention, thus the composition invention provides the ligand by e.g., encapsulation in liposomes, microparticles, microcapsules, recombinant cells capable of expressing the mutant viruses, receptor mediated endocytosis (see, e.g., Wu et al. (1987) J. Biol. Chem. 262:4429-4432). Methods of introduction include, but are not limited to, intradermal, intramuscular, intraperitoneal, intravenous, subcutaneous, intranasal, epidural, and oral routes. The composition may be administered by any convenient route, for example by infusion or bolus injection, by absorption through epithelial or mucocutaneous linings (e.g., oral mucosa, rectal and intestinal mucosa, etc.) and may be administered together with other biologically active agents. Administration can be systemic or local.

[0459] The pharmaceutical composition can be also delivered in a vesicle, in particular a liposome (see Langer (1990) Science 249:1527-1533; Treat et al. (1989) in Liposomes in the Therapy of Infectious Disease and Cancer, Lopez Berestein and Fidler (eds.), Liss, New York, pp. 353-365; Lopez-Berestein, ibid., pp. 317-327; see generally ibid.).

[0460] In certain situations, the pharmaceutical composition can be delivered in a controlled release system. In one embodiment, a pump may be used (see Langer, supra; Sefton (1987) CRC Crit. Ref. Biomed. Eng. 14:201). In another embodiment, polymeric materials can be used; see, Medical Applications of Controlled Release, Langer and Wise (eds.), CRC Pres., Boca Raton, Fla. (1974). In yet another embodiment, a controlled release system can be placed in proximity of the composition's target, thus requiring only a fraction of the systemic dose (see, e.g., Goodson, in Medical Applications of Controlled Release, supra, vol. 2, pp. 115-138, 1984).

[0461] The injectable preparations may include dosage forms for intravenous, subcutaneous, intracutaneous and intramuscular injections, drip infusions, etc. These injectable preparations may be prepared by methods publicly known. For example, the injectable preparations may be prepared, e.g., by dissolving, suspending or emulsifying the antibody or its salt described above in a sterile aqueous medium or an oily medium conventionally used for injections. As the aqueous medium for injections, there are, for example, physiological saline, an isotonic solution containing glucose and other auxiliary agents, etc., which may be used in combination with an appropriate solubilizing agent such as an alcohol (e.g., ethanol), a polyalcohol (e.g., propylene glycol, polyethylene glycol), a nonionic surfactant [e.g., polysorbate 80, HCO-50 (polyoxyethylene (50 mol) adduct of hydrogenated castor oil)], etc. As the oily medium, there are employed, e.g., sesame oil, soybean oil, etc., which may be used in combination with a solubilizing agent such as benzyl benzoate, benzyl alcohol, etc. The injection thus prepared is preferably filled in an appropriate ampoule. A pharmaceutical composition of the present invention can be delivered subcutaneously or intravenously with a standard needle and syringe. In addition, with respect to subcutaneous delivery, a pen delivery device readily has applications in delivering a pharmaceutical composition of the present invention. Such a pen delivery device can be reusable or disposable. A reusable pen delivery device generally utilizes a replaceable cartridge that contains a pharmaceutical composition. Once all of the pharmaceutical composition within the cartridge has been administered and the cartridge is empty, the empty cartridge can readily be discarded and replaced with a new cartridge that contains the pharmaceutical composition. The pen delivery device can then be reused. In a disposable pen delivery device, there is no replaceable cartridge. Rather, the disposable pen delivery device comes prefilled with the pharmaceutical composition held in a reservoir within the device. Once the reservoir is emptied of the pharmaceutical composition, the entire device is discarded.

[0462] Numerous reusable pen and autoinjector delivery devices have applications in the subcutaneous delivery of a pharmaceutical composition of the present invention. Examples include, but certainly are not limited to AUTOPEN™ (Owen Mumford, Inc., Woodstock, UK), DISETRONIC™ pen (Disetronic Medical Systems, Burghdorf, Switzerland), HUMALOG MIX 75/25™ pen, HUMALOG™ pen, HUMALIN 70/30™ pen (Eli Lilly and Co., Indianapolis, Ind.), NOVOPEN™I, II and III (Novo Nordisk, Copenhagen, Denmark), NOVOPEN JUNIOR™ (Novo Nordisk, Copenhagen, Denmark), BD™ pen (Becton Dickinson, Franklin Lakes, N.J.), OPTIPENT™, OPTIPEN PRO™, OPTIPEN STARLET™, and OPTICLIKT™ (sanofi-aventis, Frankfurt, Germany), to name only a few. Examples of disposable pen delivery devices having

applications in subcutaneous delivery of a pharmaceutical composition of the present invention include, but certainly are not limited to the SOLOSTAR™ pen (sanofi-aventis), the FLEXPEN™ (Novo Nordisk), and the KWIKPEN™ (Eli Lilly).

[0463] Advantageously, the pharmaceutical compositions for oral or parenteral use described above are prepared into dosage forms in a unit dose suited to fit a dose of the active ingredients. Such dosage forms in a unit dose include, for example, tablets, pills, capsules, injections (ampoules), suppositories, etc. The amount of the aforesaid antibody contained is generally about 5 to about 500 mg per dosage form in a unit dose; especially in the form of injection, it is preferred that the aforesaid antibody is contained in about 5 to about 100 mg and in about 10 to about 250 mg for the other dosage forms.

[0464] The invention provides therapeutic methods in which the ligand, eg, antibody or antibody fragment, of the invention is useful to treat hypercholesterolemia associated with a variety of conditions involving hPCSK9. The anti-PCSK9 ligands, eg, antibodies or antibody fragments, of the invention are particularly useful for the treatment of hypercholesterolemia and the like. Combination therapies may include the anti-PCSK9 ligand of the invention with, for example, one or more of any agent that (1) induces a cellular depletion of cholesterol synthesis by inhibiting 3-hydroxy-3-methylglutaryl (HMG)-coenzyme A (CoA) reductase, such as cerivastatin, atorvastatin, simvastatin, pitavastatin, rosuvastatin, fluvastatin, lovastatin, pravastatin; (2) inhibits cholesterol uptake and or bile acid re-absorption; (3) increase lipoprotein catabolism (such as niacin); and activators of the LXR transcription factor that plays a role in cholesterol elimination such as 22-hydroxycholesterol or fixed combinations such as ezetimibe plus simvastatin; a statin with a bile resin (e.g., cholestyramine, colestipol, colesevelam), a fixed combination of niacin plus a statin (e.g., niacin with lovastatin); or with other lipid lowering agents such as omega-3-fatty acid ethyl esters (for example, omacor).

[0465] Ligands of the invention are useful, for instance, in specific binding assays, for genotyping or phenotyping humans, affinity purification of the PCSK9 and in screening assays to identify other antagonists of PCSK9 activity. Some of the ligands of the invention are useful for inhibiting binding of PCSK9 to a congnate human receptor or protein, or inhibiting PCSK9-mediated activities.

[0466] The invention encompasses anti-PCSK9 (eg, PCSK9) antibody ligands having a modified glycosylation pattern. In some applications, modification to remove undesirable glycosylation sites may be useful, or e.g., removal of a fucose moiety to increase antibody dependent cellular cytotoxicity (ADCC) function (see Shield et al. (2002) JBC 277:26733). In other applications, modification of galactosylation can be made in order to modify complement dependent cytotoxicity (CDC).

[0467] In an example, the invention features a pharmaceutical composition comprising a ligand of the invention, wherein the ligand is or comprises a recombinant human antibody or fragment thereof which specifically binds the PCSK9 (eg, a rare variant as described herein) and a pharmaceutically acceptable carrier. In one embodiment, the invention features a composition which is a combination of an antibody ligand or antigen-binding fragment of an antibody of the invention, and a second therapeutic agent. The second therapeutic agent may be any of an anti-inflammatory agent, an anti-angiogenesis agent, a painkiller, a diuretic, a chemotherapeutic agent, an antineoplastic agent, a vasodilator, a vasoconstrictor, a statin, a beta blocker, a nutrient, an adjuvant, an anti-obesity agent and an anti-diabetes agent.

[0468] "Pharmaceutically acceptable" refers to approved or approvable by a regulatory agency of the USA Federal or a state government or listed in the U.S. Pharmacopeia or other generally recognized pharmacopeia for use in animals, including humans. A "pharmaceutically acceptable carrier, excipient, or adjuvant" refers to an carrier, excipient, or adjuvant that can be administered to a subject, together with an agent, e.g., any antibody or antibody chain described herein, and which does not destroy the pharmacological activity thereof and is nontoxic when administered in doses sufficient to deliver a therapeutic amount of the agent.

[0469] In an example, the invention features a method for inhibiting PCSK9 activity using the anti-PCSK9 ligand of the invention (eg, an antibody or antigen-binding portion of the antibody of the invention), wherein the therapeutic method comprises administering a therapeutically effective amount of a pharmaceutical composition comprising the ligand. The disorder treated is any disease or condition which is improved, ameliorated, inhibited or prevented by removal, inhibition or reduction of PCSK9 activity.

[0470] By the phrase "therapeutically effective amount" is meant an amount that produces the desired effect for which it is administered. The exact amount will depend on the purpose of the treatment, and will be ascertainable by one skilled in the art using known techniques (see, for example, Lloyd (1999) The Art, Science and Technology of Pharmaceutical Compounding).

Genotyping & Phenotyping

[0471] The skilled person will be familiar with techniques that can be used for accurate genotyping and application to the invention. These include the following.

1 Hybridization-based methods

1.1 Dynamic allele-specific hybridization
1.2 Molecular beacons
1.3 SNP microarrays

2 Enzyme-based methods

2.1 Restriction fragment length polymorphism
2.2 PCR-based methods
2.3 Flap endonuclease
2.4 Primer extension
2.5 5'- nuclease
2.6 Oligonucleotide Ligation Assay

3 Other post-amplification methods based on physical properties of DNA

3.1 Single strand conformation polymorphism
3.2 Temperature gradient gel electrophoresis
3.3 Denaturing high performance liquid chromatography
3.4 High-resolution melting of the entire amplicon
3.5 Use of DNA mismatch-binding proteins
3.6 SNPlex (SNPlex™ is a proprietary genotyping platform sold by Applied Biosystems).

[0472] Next-generation sequencing technologies such as pyrosequencing is also useful.

[0473] Reference is also made to GB2444410A and the genotyping method disclosed therein, which is incorporated herein by reference in its entirety.

[0474] Miniaturized assays, such as microarrays with oligonucleotide reagents immobilized on small surfaces, are frequently proposed for large-scale mutation analysis and high-throughput genotyping (Large-scale identification, mapping, and genotyping of single-nucleotide polymorphisms in the human genome (Wang DG, Fan JB, Siao CJ, Berno A, Young P, Sapolsky R, Ghandour G, Perkins N, Winchester E, Spencer J, Kruglyak L, Stein L, Hsie L, Topaloglou T, Hubbell E, Robinson E, Mittmann M, Morris MS, Shen N, Kilburn D, Rioux J, Nusbaum C, Rozen S, Hudson TJ, Lipshutz R, Chee M, Lander ES, Science. 1998 May 15; 280(5366):1077-82). Other high-throughput methods discriminate alleles by differential hybridization, primer extension, ligation and cleavage of an allele-specific probe (Review Accessing genetic variation: genotyping single nucleotide polymorphisms, Syvänen AC, Nat Rev Genet. 2001 Dec; 2(12):930-42; Review Techniques patents for SNP genotyping, Twyman RM, Primrose SB, Pharmacogenomics. 2003 Jan; 4(1):67-79).

[0475] An approach for a fully automated, large-scale SNP analysis is the 'homogeneous' assay, i.e. a single-phase assay without separation steps, permitting continual monitoring during amplification. The TaqMan™ assay (Applied Biosystems), originally designed for quantitative real-time PCR, is a homogeneous, single-step assay also used in determination of mutation status of DNA (see, eg, A.A. Komar (ed.), Single Nucleotide Polymorphisms, Methods in Molecular Biology 578, DOI 10.1007/978-1-60327-411-1_19, Humana Press, a part of Springer Science+Business Media, LLC; and Single Nucleotide Polymorphisms, Methods in Molecular Biology™ Volume 578, 2009, pp 293-306, The TaqMan Method for SNP Genotyping, Gong-Qing Shen *et al*). The TaqMan SNP Genotyping Assay exploits the 5'-exonuclease activity of AmpliTaq Gold™ DNA polymerase to cleave a doubly labeled probe hybridized to the SNP-containing sequence of ssDNA. Cleavage separates a 5'-fluorophore from a 3'-quencher leading to detectable fluorescent signal. The use of two allele-specific probes carrying different fluorophores permits SNP determination in the same tube without any post-PCR processing. Genotype is determined from the ratio of intensities of the two fluorescent probes at the end of amplification. Thus, rather than taking advantage of the full set of real-time PCR data as in quantitative studies, only end-point data are used.

[0476] TaqMan SNP genotyping in a high-throughput, automated manner is facilitated by the use of validated Pre-made TaqMan® Genotyping assays, but Custom TaqMan® Assays may also be used (High-throughput genotyping with single nucleotide polymorphisms, Ranade K, Chang MS, Ting CT, Pei D, Hsiao CF, Olivier M, Pesich R, Hebert J, Chen YD, Dzau VJ, Curb D, Olshen R, Risch N, Cox DR, Botstein D, Genome Res. 2001 Jul; 11(7): 1262-8; Assessment of two flexible and compatible SNP genotyping platforms: TaqMan SNP Genotyping Assays and the SNPlex Genotyping System, De la Vega FM, Lazaruk KD, Rhodes MD, Wenz MH, Mutat Res. 2005 Jun 3; 573(1-2):111-35). The results of the assay can be automatically determined by genotyping software provided with real-time thermal cyclers (e.g. IQ software of Bio-Rad, Sequence Detection Software of Applied Biosystems).

[0477] Single nucleotide polymorphisms (SNPs) can be determined using TaqMan™ real-time PCR assays (Applied Biosystems) and commercial software that assigns genotypes based on reporter probe signals at the end of amplification. An algorithm for automatic genotype caling of SNPs using the full course of TaqMan real-time data is available for use

(A. Callegaro et al, Nucleic Acids Res. 2006; 34(7): e56, Published online 2006 April 14. doi: 10.1093/nar/gkl185, PMCID: PMC1440877). The algorithm is unique in that it classifies samples according to the behavior of blanks (no DNA samples), which cluster with heterozygous samples. This method of classification eliminates the need for positive controls and permits accurate genotyping even in the absence of a genotype class, for example when one allele is rare.

[0478] The skilled person will be familiar with techniques that can be used for accurate phenotyping and application to the invention. These include the use of amino acid sequencing of isolated target protein and comparison of sequences from different variants (eg, with the most common variant). An antibody that specifically and selectively binds in the area of a SNP under stringent conditions can also be used to identify a particular variant. In another method, the genotype is determined and a corresponding amino acid sequence (phenotype) determined, eg, by *in silico* translation.

[0479] For convenience, the meaning of some terms and phrases used in the specification, examples, and appended claims, are provided below. Unless stated otherwise, or implicit from context, the following terms and phrases include the meanings provided below. The definitions are provided to aid in describing particular embodiments, and are not intended to limit the claimed invention, because the scope of the invention is limited only by the claims. Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. If there is an apparent discrepancy between the usage of a term in the art and its definition provided herein, the definition provided within the specification shall prevail.

[0480] For convenience, certain terms employed herein, in the specification, examples and appended claims are collected here.

[0481] The terms "decrease", "reduced", or "reduction" are all used herein to mean a decrease by a statistically significant amount. In some embodiments, "reduce," "reduction" or "decrease" typically means a decrease by at least 10% as compared to a reference level (e.g. the absence of a given treatment) and can include, for example, a decrease by at least about 10%, at least about 20%, at least about 25%, at least about 30%, at least about 35%, at least about 40%, at least about 45%, at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 95%, at least about 98%, at least about 99% , or more. As used herein, "reduction" does not encompass a complete reduction as compared to a reference level. A decrease can be preferably down to a level accepted as within the range of normal for an individual without a given disorder. However, for example, for the purposes of lowering or reducing cholesterol level, for example, a reduction by about 5-10 points can be considered a "decrease" or "reduction."

[0482] In certain aspects of all embodiments of the invention, the term "inhibition" is used. Inhibition refers and refers to decrease by at least 10% as compared to a reference level (e.g. the absence of a given treatment) and can include, for example, a decrease by at least about 10%, at least about 20%, at least about 25%, at least about 30%, at least about 35%, at least about 40%, at least about 45%, at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 95%, at least about 98%, at least about 99% , or more including 100% inhibition as compared to a reference level. "Complete inhibition" refers to a 100% inhibition as compared to a reference level.

[0483] The terms "increased", "increase", "enhance", or "activate" are all used herein to mean an increase by a statically significant amount. In some embodiments, the terms "increased", "increase", "enhance", or "activate" can mean an increase of at least 10% as compared to a reference level, for example an increase of at least about 20%, or at least about 30%, or at least about 40%, or at least about 50%, or at least about 60%, or at least about 70%, or at least about 80%, or at least about 90% or up to and including a 100% increase or any increase between 10-100% as compared to a reference level, or at least about a 2-fold, or at least about a 3-fold, or at least about a 4-fold, or at least about a 5-fold or at least about a 10-fold increase, or any increase between 2-fold and 10-fold or greater as compared to a reference level. In the context of a marker or symptom, an "increase" is a statistically significant increase in such level.

[0484] As used herein, the term "substantially" refers to the qualitative condition of exhibiting total or near-total extent or degree of a characteristic or property of interest. One of ordinary skill in the biological arts will understand that biological and chemical phenomena rarely, if ever, go to completion and/or proceed to completeness or achieve or avoid an absolute result. The term "substantially" is therefore used herein to capture the potential lack of completeness inherent in many biological and chemical phenomena. For the removal of doubt, "substantially" can refer to at least a 90% extent or degree of a characteristic or property of interest, e.g. at least 90%, at least 92%, at least 95%, at least 98%, at least 99% or greater.

[0485] As used herein, a "subject" means a human or animal. Usually the animal is a vertebrate such as a primate, rodent, domestic animal or game animal. Primates include chimpanzees, cynomologous monkeys, spider monkeys, and macaques, e.g., Rhesus. Rodents include mice, rats, woodchucks, ferrets, rabbits and hamsters. In some embodiments, the subject is a mammal, e.g., a primate, e.g., a human. The terms, "individual," "patient" and "subject" are used interchangeably herein. In some embodiments, the subject can be a non-human vertebrate, e.g. a primate, a rodent, a mouse, a rat, a pig, a sheep, a zebrafish, a frog, etc.

[0486] Preferably, the subject is a mammal. The mammal can be a human, non-human primate, mouse, rat, dog, cat, horse, or cow, but is not limited to these examples. Mammals other than humans can be advantageously used as subjects

that represent animal models of a disease or condition, e.g., a cardiovascular condition. A subject can be male or female.

[0487] A subject can be one who has been previously diagnosed with or identified as suffering from or having a condition in need of treatment or one or more complications related to such a condition, and optionally, have already undergone treatment for the condition or the one or more complications related to the condition. Alternatively, a subject can also be one who has not been previously diagnosed as having the condition or one or more complications related to the condition. For example, a subject can be one who exhibits one or more risk factors for the condition or one or more complications related to the condition or a subject who does not exhibit risk factors.

[0488] A "subject in need" or "human in need" of treatment for a particular condition can be a subject having that condition, such as increased cholesterol levels, diagnosed as having that condition, or at risk of developing that condition.

[0489] As used herein, the terms "protein" and "polypeptide" are used interchangeably herein to designate a series of amino acid residues, connected to each other by peptide bonds between the alpha-amino and carboxy groups of adjacent residues. The terms "protein", and "polypeptide" refer to a polymer of amino acids with natural amino acids. When referring to "modified polypeptides" one refers to polypeptides that include modified amino acids (e.g., phosphorylated, glycated, glycosylated, etc.) and amino acid analogs, regardless of its size or function. "Protein" and "polypeptide" are often used in reference to relatively large polypeptides, whereas the term "peptide" is often used in reference to small polypeptides, but usage of these terms in the art overlaps. The terms "protein" and "polypeptide" are used interchangeably herein when referring to a gene product and fragments thereof. Thus, exemplary polypeptides or proteins include gene products, naturally occurring proteins with the specified sequence. One can also use peptide homologs, peptide orthologs, peptide paralogs, peptide fragments and other equivalents, variants, fragments, and analogs of the peptides as these terms are understood by one of ordinary skill in the art.

[0490] As used herein, the term "nucleic acid" or "nucleic acid sequence" refers to any molecule, preferably a polymeric molecule, incorporating units of ribonucleic acid, deoxyribonucleic acid. The nucleic acid can be either single-stranded or double-stranded. A single-stranded nucleic acid can be one nucleic acid strand of a denatured double- stranded DNA. Alternatively, it can be a single-stranded nucleic acid not derived from any double-stranded DNA. In one aspect, the nucleic acid can be DNA. In another aspect, the nucleic acid can be RNA. Suitable nucleic acid molecules are DNA, including genomic DNA or cDNA. Other suitable nucleic acid molecules are RNA, including mRNA. In some aspects one can also use analogs of nucleic acids.

[0491] As used herein, the term "nucleic acid probe" refers to an isolated oligonucleotide molecule having a nucleic acid sequence which can hybridize to a target nucleic acid sequence, e.g. specifically hybridize to the target sequence. In some embodiments, a nucleic acid probe can further comprise a detectable label. In some embodiments, a nucleic acid probe can be attached to a solid surface. In some embodiments, a nucleic acid from is from about 5 nt to about 100 nt in length.

[0492] As used herein, the term "siRNA" refers to a nucleic acid that forms an RNA molecule comprising two individual strands of RNA which are substantially complementary to each other. Typically, the siRNA is at least about 15-40 nucleotides in length (e.g., each complementary sequence of the double stranded siRNA is about 15-40 nucleotides in length, and the double stranded siRNA is about 15-40 base pairs in length, preferably about 19-25 base nucleotides, e.g., 19, 20, 21, 22, 23, 24, or 25 nucleotides in length). In some embodiments, a siRNA can be blunt-ended. In some embodiments, a siRNA can comprise a 3' and/or 5' overhang on each strand having a length of about 0, 1, 2, 3, 4, or 5 nucleotides. The length of the overhang is independent between the two strands, i.e., the length of the overhang on one strand is not dependent on the length of the overhang on the second strand. The siRNA molecules can also comprise a 3' hydroxyl group. In some embodiments, the siRNA can comprise a 5' phosphate group. A siRNA has the ability to reduce or inhibit expression of a gene or target RNA when the siRNA is present or expressed in the same cell as the target gene, e.g. the target RNA. siRNA-dependent post-transcriptional silencing of gene expression involves cutting the target RNA molecule at a site guided by the siRNA.

[0493] As used herein, "PCSK9" or "proprotein convertase subtilisin/kexin type 9" refers to a serine protease involved in regulating the levels of the low density lipoprotein receptor (LDLR) protein (Horton et al., 2007; Seidah and Prat, 2007). PCSK9 has been shown to directly interact with the LDLR protein, be endocytosed along with the LDLR, and co-immunofluoresce with the LDLR throughout the endosomal pathway (Lagace et al., 2006). PCSK9 is a prohormone-proprotein convertase in the subtilisin (S8) family of serine proteases (Seidah et al., 2003). The sequence of PCSK9 for a variety of species is known, e.g., human PCSK9 (NCBI Gene ID No: 255738). Nucleotide and polypeptide sequences for a number of PCSK9 isoforms are provided herein, e.g., SEQ ID NOs: 1-37.

[0494] PCSK9 exists as both a pro-form and a mature form. Autocatalysis of the PCSK9 proform occurs between Gln152 and Ser153 (VFAQ|SIP (SEQ ID NO: 67)) (Naureckiene et al., 2003), and has been shown to be required for its secretion from cells (Seidah et al., 2003). The inactive form prior to this cleavage can be referred to herein as the "inactive", "pro-form", or "unprocessed" form of PCSK9. The C-terminal fragment generated by the autocatalysis event can be referred to herein as the "mature," "cleaved", "processed" or "active" PCSK9. Examples of pro-form and mature PCSK9 isoforms are provided herein, see, e.g. SEQ ID NOs: 1-27.

[0495] As used herein, the "catalytic domain" of PCSK9 refers to the portion of a PCSK9 polypeptide corresponding

to positions 153 to 449 of PCSK9, e.g. of SEQ ID NO: 1. As used herein, the "C-terminal domain" of PCSK9 refers to the portion of a PCSK9 polypeptide corresponding to positions 450-692 of PCSK9, e.g., of SEQ ID NO: 1.

[0496] As used herein, a disease or condition "mediated by PCSK9" refers to a disease or condition which is caused by or characterized by a change in PCSK9, e.g. a change in expression level, a change in activity, and/or the presence of a variant or mutation of PCSK9. Non-limiting examples of such diseases or conditions can include, for example, a lipid disorder, hyperlipoproteinemia, hyperlipidemia; dyslipidemia; hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication, type II diabetes, high blood pressure, and a cardiovascular disease or condition. Claudication mentioned herein can be claudication associated with elevated cholesterol. In an example, the disease or condition is an inflammatory or autoimmune disease or condition. Methods of identifying and/or diagnosing such diseases and conditions are well known to medical practitioners of ordinary skill.

[0497] A subject at risk of having or developing a disease or condition mediated by PCSK9 can be a subject exhibiting one or more signs or symptoms of such a disease or condition or having one or more risk factors for such a disease or condition, e.g. being overweight, having elevated cholesterol level, comprising one or more genetic polymorphisms known to predispose to the disease or condition, e.g., elevated cholesterol level, such as having a mutation in the LDLR (encoding low-density lipoprotein receptor) or APOB (encoding apolipoprotein B) or in the PCSK9 gene and/or having a family history of such a disease or condition.

[0498] As used herein, "ligand" refers to a molecule which can bind, e.g., specifically bind, to a second molecule or receptor. In some embodiments, a ligand can be, e.g., an antibody, antibody fragment, antibody portion, and/or affibody.

[0499] The term "variant" as used herein refers to a peptide or nucleic acid that differs from the polypeptide or nucleic acid (eg, the most common one in humans, eg, most frequent in a database as disclosed herein, such as the 1000 Genomes Project database) by one or more amino acid or nucleic acid deletions, additions, yet retains one or more specific functions or biological activities of the naturally occurring molecule. Amino acid substitutions include alterations in which an amino acid is replaced with a different naturally-occurring amino acid residue. Such substitutions may be classified as "conservative", in which case an amino acid residue contained in a polypeptide is replaced with another naturally occurring amino acid of similar character either in relation to polarity, side chain functionality or size. Such conservative substitutions are well known in the art. Substitutions encompassed by the present invention may also be "non-conservative", in which an amino acid residue which is present in a peptide is substituted with an amino acid having different properties, such as naturally-occurring amino acid from a different group (e.g., substituting a charged or hydrophobic amino; acid with alanine), or alternatively, in which a naturally-occurring amino acid is substituted with a non-conventional amino acid. In some embodiments amino acid substitutions are conservative. Also encompassed within the term variant when used with reference to a polynucleotide or polypeptide, refers to a polynucleotide or polypeptide that can vary in primary, secondary, or tertiary structure, as compared to a reference polynucleotide or polypeptide, respectively (e.g., as compared to a wild- type polynucleotide or polypeptide).

[0500] Variants of PCSK9 are provided elsewhere herein. Variants of PCSK9 can include the forms described herein as a, f, c, r, p, m, e h, aj, and q. Sequences of these variants are provided herein, see, e.g, SEQ ID NOs:1-27 and in Tables 1, 2 and 5.

[0501] In some aspects, one can use "synthetic variants", "recombinant variants", or "chemically modified" polynucleotide variants or polypeptide variants isolated or generated using methods well known in the art. "Modified variants" can include conservative or non-conservative amino acid changes, as described below. Polynucleotide changes can result in amino acid substitutions, additions, deletions, fusions and truncations in the polypeptide encoded by the reference sequence. Some aspects use include insertion variants, deletion variants or substituted variants with substitutions of amino acids, including insertions and substitutions of amino acids and other molecules) that do not normally occur in the peptide sequence that is the basis of the variant, for example but not limited to insertion of ornithine which do not normally occur in human proteins. The term "conservative substitution," when describing a polypeptide, refers to a change in the amino acid composition of the polypeptide that does not substantially alter the polypeptide's activity. For example, a conservative substitution refers to substituting an amino acid residue for a different amino acid residue that has similar chemical properties. Conservative amino acid substitutions include replacement of a leucine with an isoleucine or valine, an aspartate with a glutamate, or a threonine with a serine.

[0502] "Conservative amino acid substitutions" result from replacing one amino acid with another having similar structural and/or chemical properties, such as the replacement of a leucine with an isoleucine or valine, an aspartate with a glutamate, or a threonine with a serine. Thus, a "conservative substitution" of a particular amino acid sequence refers to substitution of those amino acids that are not critical for polypeptide activity or substitution of amino acids with other amino acids having similar properties (e.g., acidic, basic, positively or negatively charged, polar or nonpolar, etc.) such that the substitution of even critical amino acids does not reduce the activity of the peptide, (i.e. the ability of the peptide to penetrate the blood brain barrier (BBB)). Conservative substitution tables providing functionally similar amino acids are well known in the art. For example, the following six groups each contain amino acids that are conservative substitutions for one another: 1) Alanine (A), Serine (S), Threonine (T); 2) Aspartic acid (D), Glutamic acid (E); 3) Asparagine (N), Glutamine (Q); 4) Arginine (R), Lysine (K); 5) Isoleucine (I), Leucine (L), Methionine (M), Valine (V); and 6) Pheny-

lalanine (F), Tyrosine (Y), Tryptophan (W). (See also Creighton, Proteins, W. H. Freeman and Company (1984), incorporated by reference in its entirety.) In some embodiments, individual substitutions, deletions or additions that alter, add or delete a single amino acid or a small percentage of amino acids can also be considered "conservative substitutions" if the change does not reduce the activity of the peptide. Insertions or deletions are typically in the range of about 1 to 5 amino acids. The choice of conservative amino acids may be selected based on the location of the amino acid to be substituted in the peptide, for example if the amino acid is on the exterior of the peptide and expose to solvents, or on the interior and not exposed to solvents.

[0503] In alternative embodiments, one can select the amino acid which will substitute an existing amino acid based on the location of the existing amino acid, i.e. its exposure to solvents (i.e. if the amino acid is exposed to solvents or is present on the outer surface of the peptide or polypeptide as compared to internally localized amino acids not exposed to solvents). Selection of such conservative amino acid substitutions are well known in the art, for example as disclosed in Dordo et al, J. Mol Biol, 1999, 217, 721-739 and Taylor et al, J. Theor. Biol. 119(1986);205-218 and S. French and B. Robson, J. Mol. Evol. 19(1983)171. Accordingly, one can select conservative amino acid substitutions suitable for amino acids on the exterior of a protein or peptide (i.e. amino acids exposed to a solvent), for example, but not limited to, the following substitutions can be used: substitution of Y with F, T with S or K, P with A, E with D or Q, N with D or G, R with K, G with N or A, T with S or K, D with N or E, I with L or V, F with Y, S with T or A, R with K, G with N or A, K with R, A with S, K or P.

[0504] In alternative embodiments, one can also select conservative amino acid substitutions encompassed suitable for amino acids on the interior of a protein or peptide, for example one can use suitable conservative substitutions for amino acids is on the interior of a protein or peptide (i.e. the amino acids are not exposed to a solvent), for example but not limited to, one can use the following conservative substitutions: where Y is substituted with F, T with A or S, I with L or V, W with Y, M with L, N with D, G with A, T with A or S, D with N, I with L or V, F with Y or L, S with A or T and A with S, G, T or V. In some embodiments, non-conservative amino acid substitutions are also encompassed within the term of variants.

[0505] As used herein an "antibody" refers to IgG, IgM, IgA, IgD or IgE molecules or antigen-specific antibody fragments thereof (including, but not limited to, a Fab, $F(ab')_2$, Fv, disulphide linked Fv, scFv, single domain antibody, closed conformation multispecific antibody, disulphide-linked scfv, diabody), whether derived from any species that naturally produces an antibody, or created by recombinant DNA technology; whether isolated from serum, B-cells, hybridomas, transfectomas, yeast or bacteria. Antibodies can be humanized using routine technology.

[0506] As described herein, an "antigen" is a molecule that is bound by a binding site on an antibody agent. Typically, antigens are bound by antibody ligands and are capable of raising an antibody response *in vivo.* An antigen can be a polypeptide, protein, nucleic acid or other molecule or portion thereof. The term "antigenic determinant" refers to an epitope on the antigen recognized by an antigen-binding molecule, and more particularly, by the antigen-binding site of said molecule.

[0507] As used herein, the term "antibody fragment" refers to a polypeptide that includes at least one immunoglobulin variable domain or immunoglobulin variable domain sequence and which specifically binds a given antigen. An antibody fragment can comprise an antibody or a polypeptide comprising an antigen-binding domain of an antibody. In some embodiments, an antibody fragment can comprise a monoclonal antibody or a polypeptide comprising an antigen-binding domain of a monoclonal antibody. For example, an antibody can include a heavy (H) chain variable region (abbreviated herein as VH), and a light (L) chain variable region (abbreviated herein as VL). In another example, an antibody includes two heavy (H) chain variable regions and two light (L) chain variable regions. The term "antibody fragment" encompasses antigen-binding fragments of antibodies (e.g., single chain antibodies, Fab and sFab fragments, F(ab')2, Fd fragments, Fv fragments, scFv, and domain antibodies (dAb) fragments (see, e.g. de Wildt et al., Eur J. Immunol. 1996; 26(3):629-39; which is incorporated by reference herein in its entirety)) as well as complete antibodies. An antibody can have the structural features of IgA, IgG, IgE, IgD, IgM (as well as subtypes and combinations thereof). Antibodies can be from any source, including mouse, rabbit, pig, rat, and primate (human and non-human primate) and primatized antibodies. Antibodies also include midibodies, humanized antibodies, chimeric antibodies, and the like.

[0508] As used herein, "antibody variable domain" refers to the portions of the light and heavy chains of antibody molecules that include amino acid sequences of Complementarity Determining Regions (CDRs; ie., CDR1, CDR2, and CDR3), and Framework Regions (FRs). VH refers to the variable domain of the heavy chain. VL refers to the variable domain of the light chain. According to the methods used in this invention, the amino acid positions assigned to CDRs and FRs may be defined according to Kabat (Sequences of Proteins of Immunological Interest (National Institutes of Health, Bethesda, Md., 1987 and 1991)) or according to IMGT nomenclature.

[0509] D domain or region refers to the diversity domain or region of an antibody chain. J domain or region refers to the joining domain or region of an antibody chain.

[0510] An antibody "gene segment", e.g. a VH gene segment, D gene segment, or JH gene segment refers to oligonucleotide having a nucleic acid sequence that encodes that portion of an antibody, e.g. a VH gene segment is an oligonucleotide comprising a nucleic acid sequence that encodes a polypeptide VH domain.

[0511] The VH and VL regions can be further subdivided into regions of hypervariability, termed "complementarity determining regions" ("CDR"), interspersed with regions that are more conserved, termed "framework regions" ("FR"). The extent of the framework region and CDRs has been precisely defined (see, IMGT or Kabat, E. A., et al. (1991) Sequences of Proteins of Immunological Interest, Fifth Edition, U.S. Department of Health and Human Services, NIH Publication No. 91-3242, and Chothia, C. et al. (1987) J. Mol. Biol. 196:901-917; which are incorporated by reference herein in their entireties). Each VH and VL is typically composed of three CDRs and four FRs, arranged from amino-terminus to carboxy-terminus in the following order: FR1, CDR1, FR2, CDR2, FR3, CDR3, FR4.

[0512] The terms "antigen-binding fragment" or "antigen-binding domain", which are used interchangeably herein are used to refer to one or more fragments of a full length antibody that retain the ability to specifically bind to a target of interest. Examples of binding fragments encompassed within the term "antigen-binding fragment" of a full length antibody include (i) a Fab fragment, a monovalent fragment consisting of the VL, VH, CL and CH1 domains; (ii) a F(ab')2 fragment, a bivalent fragment including two Fab fragments linked by a disulfide bridge at the hinge region; (iii) an Fd fragment consisting of the VH and CH1 domains; (iv) an Fv fragment consisting of the VL and VH domains of a single arm of an antibody, (v) a dAb fragment (Ward et al., (1989) Nature 341:544-546; which is incorporated by reference herein in its entirety), which consists of a VH or VL domain; and (vi) an isolated complementarity determining region (CDR) that retains specific antigen-binding functionality.

[0513] As used herein, the term "antibody binding site" refers to a polypeptide or domain that comprises one or more CDRs of an antibody and is capable of binding an antigen. For example, the polypeptide comprises a CDR3 (eg, HCDR3). For example the polypeptide comprises CDRs 1 and 2 (eg, HCDR1 and 2) or CDRs 1-3 of a variable domain of an antibody (eg, HCDRs1-3). In an example, the antibody binding site is provided by a single variable domain (eg, a VH or VL domain). In another example, the binding site comprises a VH/VL pair or two or more of such pairs.

[0514] As used herein, the term "specific binding" refers to a chemical interaction between two molecules, compounds, cells and/or particles wherein the first entity binds to the second, target entity with greater specificity and affinity than it binds to a third entity which is a non-target. For example, in an diagnostic test the specific binding of a ligand can distinguish between two variant PCSK9 proteins as described herein. In some embodiments, specific binding can refer to an affinity of the first entity for the second target entity which is at least 10 times, at least 50 times, at least 100 times, at least 500 times, at least 1000 times or greater than the affinity for the third nontarget entity. In the context of oligonucleotide strands which interact via hybridization, specific binding can be "specific hybridization."

[0515] Additionally, and as described herein, a recombinant human(ized) antibody can be further optimized to decrease potential immunogenicity, while maintaining functional activity, for therapy in humans. In this regard, functional activity means a polypeptide capable of displaying one or more known functional activities associated with a recombinant antibody or antibody reagent thereof as described herein. Such functional activities include, e.g. the ability to bind to a target molecule.

[0516] The term "immunizing" refers to the step or steps of administering one or more antigens to an animal so that antibodies can be raised in the animal Generally, immunizing comprises injecting the antigen or antigens into the animal. Immunization can involve one or more administrations of the antigen or antigens. Suitable methods are prime-boost and RIMMS procedures as known to the skilled person in the art.

[0517] As used herein, an "affibody" refers to a relatively small synthetic protein molecule that has high binding affinity for a target protein (e.g. for PCSK9 or a variant therefo). Affibodies are composed of a three-helix bundle domain derived from the IgG-binding domain of staphylococcal protein A. The protein domain consists of a 58 amino acid sequence, with 13 randomized amino acids affording a range of affibody variants. Despite being significantly smaller than an antibody (an affibody weighs about 6 kDa while an antibody commonly weighs about 150 kDa),
an affibody molecule works like an antibody since its binding site is approximately equivalent in surface area to the binding site of an antibody.

[0518] As used herein, "VH3-23*04" refers to a human VH domain variant comprising the polypeptide sequence of SEQ ID NO: 38. As opposed to the reference sequence, VH3-23*04 has a valine residue instead of a leucine residue (see Figures 3 and 4; L24V, numbering including signal sequence; valine at position 5 shown in Figure 4) as a result of the presence of the rs56069819 SNP in the nucleic acid sequence encoding the VH domain. As used herein, "rs56069819" refers to a mutation or variant in a VH gene segment from adenosine to cytosine (or thymine to guanine, depending upon the strand of DNA which is being read), resulting in the VH domain encoding VH3-23*04. Rs56069819 is depicted in Figure 4 and SEQ ID NO: 39, which demonstrate the T->G mutation (it is noted that the dbSNP entry for RS5606819 depicts the other strand, which comprises the A->C mutation). Further description of VH3-23*04 can be found, e.g., in US Patent Publication 2013/0071405; which is incorporated by reference herein in its entirety.

[0519] As used herein, "determine" or "determining" refers to ascertaining, e.g., by a quantitative or qualitative analysis. As used herein, "has been determined" can refer to ascertaining on the basis of previously obtained information or simultaneously obtained information.

[0520] In some aspects of all embodiments of the invention selecting can include automation such as a computer implemented software program that upon input of the relevant data such as ethnicity or a panel of SNP data can make

the determination based on the instructions set forth herein.

[0521] As used herein, "assaying" refers to assessing, evaluating, quantifying, measuring, or characterizing an analyte, e.g., measuring the level of an analyte in a sample, identifying an analyte, or detecting the presence or absence of an analyte in a sample. In some embodiments, assaying refers to detecting a presence or absence of the analyte of interest. In some embodiments, assaying refers to quantifying an amount of an analyte, e.g., providing a measure of concentration or degree of analyte abundance. In some embodiments, assaying refers to enumerating the number of molecules of analyte present in a sample and/or specimen, e.g., to determine an analyte copy number.

[0522] As used herein "multiplex" refers to the carrying out of a method or process simultaneously and in the same reaction vessel on two or more, typically three or more, different target sequences, e.g. on two or more isoforms of PCSK9, or PCSK9 and an additional target. A multiplex analysis typically includes analysis of 10-50; 10-100; 10-1000, 10-5000, 10-10000 reactions in a multiplex format, such as a multiwall, an array, or a multichannel reaction.

[0523] Often the analysis or multiplex analysis is also automated using robotics and typically software executed by a computer and may include a robotic handling of samples, automatic or robotic selection of positive or negative results, assaying for presence of absence of a target, such as a nucleic acid polymorphism or a protein variant.

[0524] The term "biological sample" or "test sample" as used herein denotes a sample taken or isolated from a biological organism, e.g., a sample from a subject. Exemplary biological samples include, but are not limited to, a biofluid sample; serum; plasma; urine; saliva; hair, epithelial cells, skin, a tumor biopsy and/or tissue sample etc. The term also includes a mixture of the above-mentioned samples. The term "test sample" or "biological sample" also includes untreated or pretreated (or pre-processed) biological samples. For the analysis of nucleic acids, the biological sample should typically comprise at least one cell comprising nucleic acids.

[0525] The test sample can be obtained by removing a sample of cells from a subject, but can also be accomplished by using previously isolated cells (e.g. isolated at a prior time point and isolated by the same or another person). In addition, the test sample can be freshly collected or a previously collected, refrigerated, frozen or otherwise preserved sample.

[0526] In some embodiments, the test sample can be an untreated test sample. As used herein, the phrase "untreated test sample" refers to a test sample that has not had any prior sample pre-treatment except for dilution and/or suspension in a solution. Exemplary methods for treating a test sample include, but are not limited to, centrifugation, filtration, sonication, homogenization, heating, freezing and thawing, and combinations thereof. In some embodiments, the test sample can be a frozen test sample, e.g., a frozen tissue. The frozen sample can be thawed before employing methods, assays and systems described herein. After thawing, a frozen sample can be centrifuged before being subjected to methods, assays and systems described herein. In some embodiments, the test sample is a clarified test sample, for example, by centrifugation and collection of a supernatant comprising the clarified test sample. In some embodiments, a test sample can be a pre-processed test sample, for example, supernatant or filtrate resulting from a treatment selected from the group consisting of centrifugation, filtration, thawing, purification, and any combinations thereof. In some embodiments, the test sample can be treated with a chemical and/or biological reagent. Chemical and/or biological reagents can be employed to protect and/or maintain the stability of the sample, including biomolecules (e.g., nucleic acid and protein) therein, during processing. One exemplary reagent is a protease inhibitor, which is generally used to protect or maintain the stability of protein during processing. The skilled artisan is well aware of methods and processes appropriate for pre-processing of biological samples required for determination of the level of an expression product as described herein.

[0527] As used herein, "genotyping" refers to a process of determining the specific allelic composition of a cell and/or subject at one or more position within the genome, e.g. by determining the nucleic acid sequence at that position. Genotyping refers to a nucleic acid analysis and/or analysis at the nucleic acid level. As used herein, "phenotyping" refers a process of determining the identity and/or composition of an expression product of a cell and/or subject, e.g. by determining the polypeptide sequence of an expression product. Phenotyping refers to a protein analysis and/or analysis at the protein level.

[0528] As used herein, the term "nucleic acid amplification" refers to the production of additional copies of a nucleic acid sequence and is typically carried out using polymerase chain reaction (PCR) or ligase chain reaction (LCR) technologies well known in the art (Dieffenbach, C. W. and G. S. Dveksler (1995) PCR Primer, a Laboratory Manual, Cold Spring Harbor Press, Plainview, N. Y.). Other methods for amplification are also contemplated in aspects of the invention.

[0529] The term "allele-specific amplification" refers to a reaction (e.g., PCR reaction) in which at least one of the primers (e.g., allele-specific primer) is chosen from a polymorphic area of gene (e.g., single nucleotide polymorphism), with the polymorphism located at or near the primer's 3'-end. A mismatched primer will not initiate amplification, whereas a matched primer will initiate amplification. The appearance of an amplification product is indicative of the presence of the polymorphism.

[0530] As used herein, "sequencing" refers to the determination of the exact order of nucleotide bases in a strand of DNA (deoxyribonucleic acid) or RNA (ribonucleic acid) or the exact order of amino acids residues or peptides in a protein. Nucleic acid sequencing can be done using Sanger sequencing or next-generation high-throughput sequencing.

[0531] As used herein "next-generation sequencing" refers to oligonucleotide sequencing technologies that have the capacity to sequence oligonucleotides at speeds above those possible with conventional sequencing methods (e.g. Sanger sequencing), due to performing and reading out thousands to millions of sequencing reactions in parallel. Non-limiting examples of next-generation sequencing methods/platforms include Massively Parallel Signature Sequencing (Lynx Therapeutics); 454 pyro-sequencing (454 Life Sciences/ Roche Diagnostics); solid-phase, reversible dye-terminator sequencing (Solexa/Illumina): SOLiD technology (Applied Biosystems); Ion semiconductor sequencing (ION Torrent); DNA nanoball sequencing (Complete Genomics); and technologies available from Pacific Biosciences, Intelligen Bio-systems, Oxford Nanopore Technologies, and Helicos Biosciences. Next-generation sequencing technologies and the constraints and design parameters of associated sequencing primers are well known in the art (see, e.g. Shendure, et al., "Next-generation DNA sequencing," Nature, 2008, vol. 26, No. 10, 1135-1145; Mardis, "The impact of next-generation sequencing technology on genetics," Trends in Genetics, 2007, vol. 24, No. 3, pp. 133-141; Su, et al., "Next-generation sequencing and its applications in molecular diagnostics" Expert Rev Mol Diagn, 2011, 11(3):333-43; Zhang et al., "The impact of next-generation sequencing on genomics", J Genet Genomics, 2011, 38(3):95-109; (Nyren, P. et al. Anal Biochem 208: 17175 (1993); Bentley, D. R. Curr Opin Genet Dev 16:545-52 (2006); Strausberg, R. L., et al. Drug Disc Today 13:569-77 (2008); U.S. Pat. No. 7,282,337; U.S. Pat. No. 7,279,563; U.S. Pat. No. 7,226,720; U.S. Pat. No. 7,220,549; U.S. Pat. No. 7,169,560; U.S. Pat. No. 6,818,395; U.S. Pat. No. 6,911,345; US Pub. Nos. 2006/0252077; 2007/0070349; and 20070070349; which are incorporated by referene herein in their entireties).

[0532] As used herein, "nucleic acid hybridization" refers to the pairing of complementary RNA and DNA strands as well as the pairing of complementary DNA single strands. In some embodiments, nucleic acid hybridization can refer to a method of determining a nucleic acid sequence and/or identity by hybridizing a nucleic acid sample with a probe, e.g. Northern or Southern blot analysis or microarray analysis.

[0533] As used herein, the terms "treat," "treatment," "treating," or "amelioration" refer to therapeutic treatments, wherein the object is to reverse, alleviate, ameliorate, inhibit, slow down or stop the progression or severity of a condition associated with a disease or disorder. The term "treating" includes reducing or alleviating at least one adverse effect or symptom of a condition, disease or disorder. Treatment is generally "effective" if one or more symptoms or clinical markers are reduced. Alternatively, treatment is "effective" if the progression of a disease is reduced or halted. That is, "treatment" includes not just the improvement of symptoms or markers, but also a cessation of, or at least slowing of, progress or worsening of symptoms compared to what would be expected in the absence of treatment. Beneficial or desired clinical results include, but are not limited to, alleviation of one or more symptom(s), diminishment of extent of disease, stabilized (*i.e.*, not worsening) state of disease, delay or slowing of disease progression, amelioration or palliation of the disease state, remission (whether partial or total), and/or decreased mortality, whether detectable or undetectable. The term "treatment" of a disease also includes providing relief from the symptoms or side-effects of the disease (including palliative treatment). For treatment to be effective a complete cure is not contemplated. The method can in certain aspects include cure as well.

[0534] As used herein, the term "pharmaceutical composition" refers to the active agent in combination with a pharmaceutically acceptable carrier e.g. a carrier commonly used in the pharmaceutical industry. The phrase "pharmaceutically acceptable" is employed herein to refer to those compounds, materials, compositions, and/or dosage forms which are, within the scope of sound medical judgment, suitable for use in contact with the tissues of human beings and animals without excessive toxicity, irritation, allergic response, or other problem or complication, commensurate with a reasonable benefit/risk ratio.

[0535] As used herein, the term "administering," refers to the placement of a compound as disclosed herein into a subject by a method or route which results in at least partial delivery of the agent at a desired site. Pharmaceutical compositions comprising the compounds disclosed herein can be administered by any appropriate route which results in an effective treatment in the subject.

[0536] Multiple compositions can be administered separately or simultaneously. Separate administration refers to the two compositions being administered at different times, e.g. at least 10, 20, 30, or 10-60 minutes apart, or 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12 hours apart. One can also administer compositions at 24 hours apart, or even longer apart. Alternatively, two or more compositions can be administered simultaneously, e.g. less than 10 or less than 5 minutes apart. Compositions administered simultaneously can, in some aspects, be administered as a mixture, with or without similar or different time release mechanism for each of the components.

[0537] As used herein, "contacting" refers to any suitable means for delivering, or exposing, an agent to at least one complex, enzyme, or cell. Exemplary delivery methods include, but are not limited to, direct delivery to cell culture medium, perfusion, injection, or other delivery method well known to one skilled in the art.

[0538] As used herein, "obtain" refers to any method of acquiring, securing, procuring, or coming into the possession of, e.g. a sample. Obtaining a biological sample from a subject can comprise physical removing a sample from a subject (e.g. drawing blood or taking a hair or saliva sample) without or without active participation from the subject; receiving a sample from a subject (e.g. the subject collects a saliva or hair sample themselves and provides it, e.g. in a container provided for the purpose); or procuring a sample from a storage facility, medical facility, or medical provider. Obtain from

the human or subject, refers to an active step of, e.g., drawing blood or taking a tissue or cell sample.

[0539] As used herein, "cholesterol level" refers to a level of one or more of total cholesterol, LDL cholesterol, HDL cholesterol, and/or triglycerides. Cholesterol levels can be the level of cholesterol in the blood of a subject.

[0540] As used herein in reference to cholesterol levels, "maintain" refers to preventing the level from worsening (e.g. increasing). In some embodiments, maintaining a particular level refers to a process that results in the cholesterol level not increasing by more than 10% over time. Maintaining may also refer to maintaining a previously achieved level. For example, if a human has received statin treatment, one can maintain the cholesterol level achieved using the statin treatment.

[0541] In some embodiments, the subject treated according to the methods described herein has previously had their cholesterol level reduced. As used herein, "previously reduced" indicates that at a prior point in time, the subject experienced a decrease in cholesterol levels. The decrease can be due to administration of a pharmaceutical composition (e.g. administration of a composition as described herein or another composition, e.g. a statin) or due to another cause, e.g. a change in diet and/or exercise.

[0542] An existing treatment for high cholesterol levels is the administration of a statin. As referred to herein, a "statin" (also known as HMG-CoA reductase inhibitors) are inhibitors of the enzyme HMG-coA reductase, which mediates cholesterol production in the liver. Statins, by competitively binding HMG-CoA reductase, prevent the binding of HMG-CoA to the enzyme and thereby inhibit the activity of the reductase (e.g. the production of mevalonate). Non-limiting examples of statins can include atorvastatin (LIPITOR™), fluvastatin (LESCOL™), lovastatin (MEVACOR™, ALTOCOR™), pitavastatin (LIVALO™), pravastatin (PRAVACHOL™), rosuvastatin (CRESTOR™), and simvastatin (ZOCOR™). Statins can be administered in combination with other agents, e.g. the combination of ezetimibe and simvastatin.

[0543] Some subjects are, or become, resistant to statin treatment. As used herein, "resistant to statin treatment" or "reduced responsiveness to statin treatment" refers to a subject exhibiting a statistically significantly lower response to the administration of a statin as compared to a reference level. The reference level can be, e.g., the average response for a population of subjects or the level of the individual subject at an earlier date. A response to statin treatment is readily measured by one of skill in the art, e.g., measurement of cholesterol levels, changes in cholesterol levels, and/or HMG-CoA reductase activity.

[0544] As used herein, the term "detectable label" refers to a molecule or moiety that can be detected, e.g. measured and/or determined to be present or absent. Detectable labels can comprise, for example, a light-absorbing dye, a fluorescent dye, or a radioactive label. Detectable labels, methods of detecting them, and methods of incorporating them into reagents (e.g. antibodies and nucleic acid probes) are well known in the art.

[0545] In some embodiments, detectable labels can include labels that can be detected by spectroscopic, photochemical, biochemical, immunochemical, electromagnetic, radiochemical, or chemical means, such as fluorescence, chemifluoresence, or chemiluminescence, or any other appropriate means. The detectable labels used in the methods described herein can be primary labels (where the label comprises a moiety that is directly detectable or that produces a directly detectable moiety) or secondary labels (where the detectable label binds to another moiety to produce a detectable signal, e.g., as is common in immunological labeling using secondary and tertiary antibodies). The detectable label can be linked by covalent or non-covalent means to the reagent. Alternatively, a detectable label can be linked such as by directly labeling a molecule that achieves binding to the reagent via a ligand-receptor binding pair arrangement or other such specific recognition molecules. Detectable labels can include, but are not limited to radioisotopes, bioluminescent compounds, chromophores, antibodies, chemiluminescent compounds, fluorescent compounds, metal chelates, and enzymes.

[0546] In other embodiments, the detectable label can be a fluorescent compound. When the fluorescently label is exposed to light of the proper wavelength, its presence can then be detected due to fluorescence. In some embodiments, a detectable label can be a fluorescent dye molecule, or fluorophore including, but not limited to fluorescein, phycoerythrin, phycocyanin, o-phthaldehyde, fluorescamine, Cy3™, Cy5™, allophycocyanine, Texas Red, peridenin chlorophyll, cyanine, tandem conjugates such as phycoerythrin-Cy5™, green fluorescent protein, rhodamine, fluorescein isothiocyanate (FITC) and Oregon Green™, rhodamine and derivatives (e.g., Texas red and tetrarhodimine isothiocynate (TRITC)), biotin, phycoerythrin, AMCA, CyDyes™, 6-carboxyfhiorescein (commonly known by the abbreviations FAM and F), 6-carboxy-2',4',7',4,7-hexachlorofiuorescein (HEX), 6-carboxy-4',5'-dichloro-2',7'-dimethoxyfiuorescein (JOE or J), N,N,N',N'-tetramethyl-6carboxyrhodamine (TAMRA or T), 6-carboxy-X-rhodamine (ROX or R), 5-carboxyrhodamine-6G (R6G5 or G5), 6-carboxyrhodamine-6G (R6G6 or G6), and rhodamine 110; cyanine dyes, e.g. Cy3, Cy5 and Cy7 dyes; coumarins, e.g umbelliferone; benzimide dyes, e.g. Hoechst 33258; phenanthridine dyes, e.g. Texas Red; ethidium dyes; acridine dyes; carbazole dyes; phenoxazine dyes; porphyrin dyes; polymethine dyes, e.g. cyanine dyes such as Cy3, Cy5, etc; BODIPY dyes and quinoline dyes. In some embodiments, a detectable label can be a radiolabel including, but not limited to ^{3}H, ^{125}I, ^{35}S, ^{14}C, ^{32}P, and ^{33}P. In some embodiments, a detectable label can be an enzyme including, but not limited to horseradish peroxidase and alkaline phosphatase. An enzymatic label can produce, for example, a chemiluminescent signal, a color signal, or a fluorescent signal. Enzymes contemplated for use as a detectable label can include, but are not limited to, malate dehydrogenase, staphylococcal nuclease, delta-V-steroid isomerase, yeast

alcohol dehydrogenase, alpha-glycerophosphate dehydrogenase, triose phosphate isomerase, horseradish peroxidase, alkaline phosphatase, asparaginase, glucose oxidase, beta-galactosidase, ribonuclease, urease, catalase, glucose-VI-phosphate dehydrogenase, glucoamylase and acetylcholinesterase. In some embodiments, a detectable label is a chemiluminescent label, including, but not limited to lucigenin, luminol, luciferin, isoluminol, theromatic acridinium ester, imidazole, acridinium salt and oxalate ester. In some embodiments, a detectable label can be a spectral colorimetric label including, but not limited to colloidal gold or colored glass or plastic (e.g., polystyrene, polypropylene, and latex) beads.

[0547] In some embodiments, reagents can also be labeled with a detectable tag, such as c-Myc, HA, VSV-G, HSV, FLAG, V5, HIS, or biotin. Other detection systems can also be used, for example, a biotin-streptavidin system. In this system, the antibodies immunoreactive (i. e. specific for) with the biomarker of interest is biotinylated. Quantity of biotinylated antibody bound to the biomarker is determined using a streptavidin-peroxidase conjugate and a chromagenic substrate. Such streptavidin peroxidase detection kits are commercially available, e. g. from DAKO; Carpinteria, CA. A reagent can also be detectably labeled using fluorescence emitting metals such as ^{152}Eu, or others of the lanthanide series. These metals can be attached to the reagent using such metal chelating groups as diethylenetriaminepentaacetic acid (DTPA) or ethylenediaminetetraacetic acid (EDTA).

[0548] As used herein, "authorization number" or "marketing authorization number" refers to a number issued by a regulatory agency upon that agency determining that a particular medical product and/or composition may be marketed and/or offered for sale in the area under the agency's jurisdiction. As used herein "regulatory agency" refers to one of the agencies responsible for evaluating, e.g, the safety and efficacy of a medical product and/or composition and controlling the sales/marketing of such products and/or compositions in a given area. The Food and Drug Administration (FDA) in the US and the European Medicines Agency (EPA) in Europe are but two examples of such regulatory agencies. Other non-limiting examples can include SDA, MPA, MHPRA, IMA, ANMAT, Hong Kong Department of Health-Drug Office, CDSCO, Medsafe, and KFDA.

[0549] As used herein, "injection device" refers to a device that is designed for carrying out injections, an injection including the steps of temporarily fluidically coupling the injection device to a person's tissue, typically the subcutaneous tissue. An injection further includes administering an amount of liquid drug into the tissue and decoupling or removing the injection device from the tissue. In some embodiments, an injection device can be an intravenous device or IV device, which is a type of injection device used when the target tissue is the blood within the circulatory system, e.g., the blood in a vein. A common, but non-limiting example of an injection device is a needle and syringe.

[0550] As used herein, a "buffer" refers to a chemical agent that is able to absorb a certain quantity of acid or base without undergoing a strong variation in pH.

[0551] As used herein, "packaging" refers to how the components are organized and/or restrained into a unit fit for distribution and/or use. Packaging can include, e.g., boxes, bags, syringes, ampoules, vials, tubes, clamshell packaging, barriers and/or containers to maintain sterility, labeling, etc.

[0552] As used herein, "instructions" refers to a display of written, printed or graphic matter on the immediate container of an article, for example the written material displayed on a vial containing a pharmaceutically active agent, or details on the composition and use of a product of interest included in a kit containing a composition of interest. Instructions set forth the method of the treatment as contemplated to be administered or performed.

[0553] As used herein, a "solid surface" refers to an object suitable for the attachment of biomolecules. Non-limiting examples of a solid surface can include a particle (including, but not limited to an agarose or latex bead or particle or a magnetic particle), a bead, a nanoparticle, a polymer, a substrate, a slide, a coverslip, a plate, a dish, a well, a membrane, and/or a grating. The solid surface can include many different materials including, but not limited to, polymers, plastics, resins, polysaccharides, silicon or silica based materials, carbon, metals, inorganic glasses, and membranes.

[0554] As used herein, "classification" of a subject, e.g., classification of the subject's ancestry refers to determining if the subject has biological ancestors who originated in a particular geographical area, and are therefore likely to have particular genetic variants found in the populations which have historically occupied that area. Classification can comprise, e.g. obtaining information on the subject's family, interviewing the subject or a family member regarding their biological family's ancestry, and/or genetic testing. Classification can be on the basis used for the 1000 Genomes Project, as will be familiar to the skilled person in the art. In some embodiments, the subject can be classified as being of a particular ancestry if at least the subject's genome comprises a substantial number of different alleles in common with other humans of that ancestry (eg, determined by reference to the 1000 Genomes Project database), for example, at least 10, 20, 30, 40, 50 or 100 or more alleles in common. Abbreviations for particular ancestral groups are provided in Table 4.

[0555] The term "statistically significant" or "significantly" refers to statistical significance and generally means a two standard deviation (2SD) or greater difference.

[0556] Other than in the operating examples, or where otherwise indicated, all numbers expressing quantities of ingredients or reaction conditions used herein should be understood as modified in all instances by the term "about." The term "about" when used in connection with percentages can mean $\pm 1\%$.

[0557] As used herein the term "comprising" or "comprises" is used in reference to compositions, methods, and

respective component(s) thereof, that are essential to the method or composition, yet open to the inclusion of unspecified elements, whether essential or not.

[0558] The term "consisting of" refers to compositions, methods, and respective components thereof as described herein, which are exclusive of any element not recited in that description of the embodiment.

[0559] As used herein the term "consisting essentially of" refers to those elements required for a given embodiment. The term permits the presence of elements that do not materially affect the basic and novel or functional characteristic(s) of that embodiment.

[0560] The singular terms "a," "an," and "the" include plural referents unless context clearly indicates otherwise. Similarly, the word "or" is intended to include "and" unless the context clearly indicates otherwise. Although methods and materials similar or equivalent to those described herein can be used in the practice or testing of this disclosure, suitable methods and materials are described below. The abbreviation, "e.g." is derived from the Latin exempli gratia, and is used herein to indicate a non-limiting example. Thus, the abbreviation "e.g." is synonymous with the term "for example."

[0561] Definitions of common terms in cell biology and molecular biology can be found in "The Merck Manual of Diagnosis and Therapy", 19th Edition, published by Merck Research Laboratories, 2006 (ISBN 0-911910-19-0); Robert S. Porter et al. (eds.), The Encyclopedia of Molecular Biology, published by Blackwell Science Ltd., 1994 (ISBN 0-632-02182-9); Benjamin Lewin, Genes X, published by Jones & Bartlett Publishing, 2009 (ISBN-10: 0763766321); Kendrew et al. (eds.), , Molecular Biology and Biotechnology: a Comprehensive Desk Reference, published by VCH Publishers, Inc., 1995 (ISBN 1-56081-569-8) and Current Protocols in Protein Sciences 2009, Wiley Intersciences, Coligan et al., eds.

[0562] Unless otherwise stated, the present invention was performed using standard procedures, as described, for example in Sambrook et al., Molecular Cloning: A Laboratory Manual (4 ed.), Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y., USA (2012); Davis et al., Basic Methods in Molecular Biology, Elsevier Science Publishing, Inc., New York, USA (1995); or Methods in Enzymology: Guide to Molecular Cloning Techniques Vol.152, S. L. Berger and A. R. Kimmel Eds., Academic Press Inc., San Diego, USA (1987); Current Protocols in Protein Science (CPPS) (John E. Coligan, et. al., ed., John Wiley and Sons, Inc.), Current Protocols in Cell Biology (CPCB) (Juan S. Bonifacino et. al. ed., John Wiley and Sons, Inc.), and Culture of Animal Cells: A Manual of Basic Technique by R. Ian Freshney, Publisher: Wiley-Liss; 5th edition (2005), Animal Cell Culture Methods (Methods in Cell Biology, Vol. 57, Jennie P. Mather and David Barnes editors, Academic Press, 1st edition, 1998) which are all incorporated by reference herein in their entireties.

[0563] Other terms are defined herein within the description of the various aspects of the invention.

[0564] All patents and other publications; including literature references, issued patents, published patent applications, and co-pending patent applications; cited throughout this application are expressly incorporated herein by reference for the purpose of describing and disclosing, for example, the methodologies described in such publications that might be used in connection with the technology described herein. These publications are provided solely for their disclosure prior to the filing date of the present application. Nothing in this regard should be construed as an admission that the inventors are not entitled to antedate such disclosure by virtue of prior invention or for any other reason. All statements as to the date or representation as to the contents of these documents is based on the information available to the applicants and does not constitute any admission as to the correctness of the dates or contents of these documents.

[0565] The description of embodiments of the disclosure is not intended to be exhaustive or to limit the disclosure to the precise form disclosed. While specific embodiments of, and examples for, the disclosure are described herein for illustrative purposes, various equivalent modifications are possible within the scope of the disclosure, as those skilled in the relevant art will recognize. For example, while method steps or functions are presented in a given order, alternative embodiments may perform functions in a different order, or functions may be performed substantially concurrently. The teachings of the disclosure provided herein can be applied to other procedures or methods as appropriate. The various embodiments described herein can be combined to provide further embodiments. Aspects of the disclosure can be modified, if necessary, to employ the compositions, functions and concepts of the above references and application to provide yet further embodiments of the disclosure. Moreover, due to biological functional equivalency considerations, some changes can be made in protein structure without affecting the biological or chemical action in kind or amount. These and other changes can be made to the disclosure in light of the detailed description. All such modifications are intended to be included within the scope of the appended claims.

[0566] Specific elements of any of the foregoing embodiments can be combined or substituted for elements in other embodiments. Furthermore, while advantages associated with certain embodiments of the disclosure have been described in the context of these embodiments, other embodiments may also exhibit such advantages, and not all embodiments need necessarily exhibit such advantages to fall within the scope of the disclosure.

[0567] It will be understood that particular configurations, aspects, examples, clauses and embodiments described herein are shown by way of illustration and not as limitations of the invention. The principal features of this invention can be employed in various embodiments without departing from the scope of the invention. Those skilled in the art will recognize, or be able to ascertain using no more than routine study, numerous equivalents to the specific procedures

described herein. Such equivalents are considered to be within the scope of this invention and are covered by the claims. All publications and patent applications mentioned in the specification are indicative of the level of skill of those skilled in the art to which this invention pertains. All publications and patent applications are herein incorporated by reference to the same extent as if each individual publication or patent application was specifically and individually indicated to be incorporated by reference. The use of the word "a" or "an" when used in conjunction with the term "comprising" in the claims and/or the specification may mean "one," but it is also consistent with the meaning of "one or more," "at least one," and "one or more than one." The use of the term "or" in the claims is used to mean "and/or" unless explicitly indicated to refer to alternatives only or the alternatives are mutually exclusive, although the disclosure supports a definition that refers to only alternatives and "and/or." Throughout this application, the term "about" is used to indicate that a value includes the inherent variation of error for the device, the method being employed to determine the value, or the variation that exists among the study subjects.

[0568] As used in this specification and claim(s), the words "comprising" (and any form of comprising, such as "comprise" and "comprises"), "having" (and any form of having, such as "have" and "has"), "including" (and any form of including, such as "includes" and "include") or "containing" (and any form of containing, such as "contains" and "contain") are inclusive or openended and do not exclude additional, unrecited elements or method steps

[0569] Any part of this disclosure may be read in combination with any other part of the disclosure, unless otherwise apparent from the context.

[0570] All of the compositions and/or methods disclosed and claimed herein can be made and executed without undue experimentation in light of the present disclosure. While the compositions and methods of this invention have been described in terms of preferred embodiments, it will be apparent to those of skill in the art that variations may be applied to the compositions and/or methods and in the steps or in the sequence of steps of the method described herein without departing from the concept, spirit and scope of the invention. All such similar substitutes and modifications apparent to those skilled in the art are deemed to be within the spirit, scope and concept of the invention as defined by the appended claims.

[0571] The present invention is described in more detail in the following non limiting Examples.

[0572] The invention addresses the need to treat humans having naturally-occurring rarer natural PCSK9 alleles, genotypes and phenotypes (rarer protein forms). In this respect, the invention provides the following aspects.

[0573] **In a First Aspect:** A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof comprising

a. selecting a human comprising (i) a proprotein convertase subtilisin/kexin type 9 (PCSK9) nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37; and/or (ii) a nucleotide sequence thereof encoding the catalytic domain or C-terminal domain of a PCSK9 protein; and

b. administering to said human an antibody or antibody fragment that specifically binds one or more a PCSK9 amino acid sequence encoded by said nucleotide sequence comprised by the human.

[0574] In an example, step (a) comprises selecting a human comprising a PCSK9 protein encoded by the nucleotide sequence of (i) or (ii).

[0575] In an example, the antibody or antibody fragment specifically binds said PCSK9 amino acid sequence. In an example, the antibody or antibody fragment binds a second PCSK9 protein comprising an amino acid sequence encoded by (i) a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37; and/or (ii) a nucleotide sequence thereof encoding the catalytic domain or C-terminal domain of a PCSK9 protein. In an example, the antibody comprises a VH domain derived from the recombination of a human VH gene segment, human D gene segments and a human JH segment, the VH gene segment comprising a nucleotide sequence that comprises a single nucleotide polymorphism with nucleotide C as indicated in rs56069819 (CTGTACCAAGCCTCCCCCAGACTCCA[A/C]CAGCTGCACCTCACACT-GGACACCT) (SEQ ID NO: 68). In an example, the VH gene segment is VH3-23*04 (SEQ ID NO: 38) encoded by a sequence comprising SEQ ID NO: 39. In an example, the antibody comprises a VH domain, wherein the VH domain comprises the framework 1 sequence of SEQ ID No. 40.

[0576] In an example, the human has been determined to comprise the nucleotide sequence of (i) and/or (ii). In an example, the human has been determined to comprise a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein encoded by the nucleotide sequence of (i) and/or (ii). In an example, the method further comprises the step of determining that the human comprises the nucleotide sequence of (i) and/or (ii).

[0577] In an example, the determining step is performed before administration of the antibody to the human. In an example, the method further comprises the step of determining that the human comprises a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein encoded by the nucleotide sequence of (i) and/or (ii). In an example, the determining step is performed before administration of the antibody to the human. In an example, the step of determining comprises assaying a biological sample from the human for (i) a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37; and/or (ii) a nucleotide sequence encoding the catalytic domain or C-terminal domain of the

PCSK9 variant protein. In an example, the assaying comprises contacting the biological sample with

c. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides that can specifically hybridize to and identify in the biological sample a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof, or that specifically hybridizes to an antisense of said sequence, wherein said nucleic acid hybridizes to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridizes to an antisense sequence thereby forming a complex when at least one nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof is present; and/or

d. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides of a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or comprising an antisense sequence of said contiguous nucleotides, wherein said sequence of contiguous nucleotides comprises at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 thereby forming a complex when a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 is present; and

detecting the presence or absence of the complex, wherein detecting the presence of the complex determines that the human comprises the PCSK9 variant protein.

[0578] In an example, the assaying comprises nucleic acid amplification and optionally one or more methods selected from sequencing, next generation sequencing, nucleic acid hybridization, and allele-specific amplification. In an example, the assaying is performed in a multiplex format. In an example the method further comprises obtaining the biological sample from the human. In an example, said biological sample comprises serum, blood, feces, tissue, a cell, urine and/or saliva of said human.

[0579] In an example, said human is or has been further determined to be substantially resistant to statin treatment. In an example, the human is receiving or has received statin treatment or has reduced responsiveness to statin treatment.

[0580] In an example, the human is further administered a statin. In an example, said antibody or antibody fragment and said statin are administered separately or simultaneously.

[0581] In an example, said human is indicated as heterozygous for a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 and/or the nucleotide sequence thereof encoding the catalytic domain- or C-terminal domain-encoding sequence of a PCSK9 protein. In an example, said human is further indicated as comprising the nucleotide sequence of SEQ ID NO: 28 and/or the catalytic domain- or C-terminal domain-encoding sequence thereof.

[0582] In an example, said human is indicated as homozygous for a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 and/or the catalytic domain- or C-terminal domain-encoding sequence thereof.

[0583] In an example, said human has been diagnosed with at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia; dyslipidemia; hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication, type II diabetes, high blood pressure, and a cardiovascular disease or condition.

[0584] In an example, said method treats or prevents in said human at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia; dyslipidemia; hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication, type II diabetes, high blood pressure, and a cardiovascular disease or condition.

[0585] Some embodiments of the technology described herein can be defined according to any of the following numbered paragraphs:

1. A method of treating and/or preventing a disease or condition mediated by proprotein convertase subtilisin/kexin type 9 (PCSK9) in a human who has been determined to comprise and/or selected as comprising a PCSK9 variant protein, the method comprising administering to the human a ligand that binds the PCSK9 variant protein to treat and/or prevent said disease or condition.

In an alternative, paragraph 1 provides:-

A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation as defined herein (eg, I474V or E670G) in SEQ ID NO: 1, wherein the antibody comprises a VH domain derived from the recombination of a human VH segment, a human D gene segment and a human JH segment, the human VH segment encoding a valine at the amino acid corresponding to position 5 of SEQ ID NO: 40 and wherein said human comprises (i) a VH gene segment encoding the framework 1 of SEQ ID NO: 40 and (ii) a nucleotide sequence encoding a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation in SEQ ID NO: 1.

In an alternative, paragraph 1 provides:-
A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation as defined herein (eg, I474V or E670G) in SEQ ID NO: 1, wherein the antibody comprises a VL domain derived from the recombination of a human VL segment and a human JL segment, the human VL segment is a Vλ or Vκ disclosed herein and wherein said human comprises (i) said VL gene segment and (ii) a nucleotide sequence encoding a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation in SEQ ID NO: 1.

In an alternative, paragraph 1 provides:-
A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation as defined herein (eg, I474V or E670G) in SEQ ID NO: 1, wherein the antibody comprises a C domain encoded by a human CH, Cλ or Cκ gene segment disclosed herein and wherein said human comprises (i) said C gene segment and (ii) a nucleotide sequence encoding a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation in SEQ ID NO: 1.

2. The method of paragraph 1, wherein said PCSK9 variant protein is selected from the group consisting of PCSK9 variant protein forms f, c, r, p, m, e, h, aj and q.
3. The method of paragraph 2, wherein the variant is mature PCSK9.
4. The method of paragraph 1, 2 or 3 further comprising assaying a biological sample from the human for the PCSK9 variant protein form.
5. A method of treating and/or preventing a disease or condition mediated by proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein encoded by (i) a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37; and/or (ii) a nucleotide sequence encoding the catalytic domain or C-terminal domain thereof in a human who has been determined as comprising and/or selected as comprising (i) the nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37; and/or (ii) the nucleotide sequence thereof encoding the catalytic domain or C-terminal domain of a PCSK9 protein, the method comprising administering to said human a ligand that binds said PCSK9 variant protein to treat and/or prevent said disease or condition.
6. The method of paragraph 5 further comprising assaying a biological sample from the human for (i) a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37; and/or (ii) a nucleotide sequence thereof encoding the catalytic domain or C-terminal domain of a PCSK9 protein.
7. The method of paragraph 6, wherein the assaying comprises nucleic acid amplification and/or one or more methods selected from sequencing, next generation sequencing, nucleic acid hybridization, and allele-specific amplification.
8. The method of paragraph 6, wherein the assaying is performed in a multiplex format.
9. The method of any one of paragraphs 1-8, further comprising obtaining the biological sample from the human.
10. The method of any one of paragraphs 1-9, wherein said human has been further determined to be and/or selected as substantially resistant to statin treatment of said disease or condition.
11. The method of any one of paragraphs 1-10, wherein the ligand is selected from an antibody, an antibody portion, an antibody fragment or an affibody.
12. The method of paragraph 11, wherein the ligand is an antibody or antibody fragment that specifically binds to a human PCSK9 selected from forms f, c, m, e, h, p, q and aj, wherein the antibody or fragment comprises a VH domain derived from the recombination of a human VH gene segment, a human D gene segment and a human JH gene segment, the VH gene segment comprising a nucleotide sequence that comprises SNP rs56069819 (SEQ ID NO: 41).
13. The ligand of paragraph 12, wherein the VH gene segment is VH3-23*04.
14. The method of any one of the paragraphs 1-13, wherein said administering further comprises administering a statin to the human.
15. The method of any one of paragraphs 1-14, wherein said ligand and said statin are administered separately or simultaneously.
16. The method of any one of paragraphs 1-15, wherein said biological sample comprises serum, blood, feces, hair, tissue, cells, urine and/or saliva of said human.
17. The method of any one of the paragraphs 1-16, wherein said human is indicated as heterozygous for a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 and/or the nucleotide sequence thereof encoring a catalytic domain- or C-terminal domain-encoding sequence of a PCSK9 protein.

18. The method of any one of paragraphs 1-17, wherein said human is indicated as comprising the nucleotide sequence of SEQ ID NO: 28 and/or the catalytic domain- or C-terminal domain-encoding sequence thereof.
19. The method of any one of paragraphs 1-18, wherein said human is indicated as homozygous for a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 and/or the nucleotide sequence thereof encoding a catalytic domain- or C-terminal domain-encoding sequence of a PCSK2 protein.
20. The method of any one of paragraphs 1-19, wherein when said human is determined to comprise and/or selected as comprising:

a. SEQ ID NO: 29 and is classified as of ASW, YRI, GBR, TSI, CLM, LWK, MXL, JPT, PUR, IBS, FIN or CEU ancestry, then administering to said human a ligand that specifically binds said PCSK9 variant protein comprising a variant encoded by SEQ ID NO: 29; or
b. SEQ ID NO: 30 and is classified as of ASW, YRI, GBR, TSI, CLM, CHB, LWK, CHS, JPT, PUR, FIN or CEU ancestry then administering to said human a ligand that specifically binds said PCSK9 variant protein comprising a variant encoded by SEQ ID NO: 30; or
c. SEQ ID NO: 32, and is classified as of ASW, GBR, TSI, CLM, JPT, PUR, IBS, FIN or CEU ancestry then administering to said human a ligand that specifically binds said PCSK9 variant protein comprising a variant encoded by SEQ ID NO: 32; or
d. SEQ ID NO: 33, and is classified as of LWK, ASW, YRI or CLM ancestry then administering to said human a ligand that specifically binds said PCSK9 variant protein comprising a variant encoded by SEQ ID NO: 33; or
e. SEQ ID NO: 34, and is classified as of LWK, ASW or YRI ancestry then administering to said human a ligand that specifically binds said PCSK9 variant protein comprising a variant encoded by SEQ ID NO: 34; or
f. SEQ ID NO: 35, and is classified as of PUR, TSI, FIN or CEU ancestry then administering to said human a ligand that specifically binds said PCSK9 variant protein comprising a variant encoded by SEQ ID NO: 35; or
g. SEQ ID NO: 36, and is classified as of LWK, ASW or YRI ancestry then administering to said human a ligand that specifically binds said PCSK9 variant protein comprising a variant encoded by SEQ ID NO: 36; or
h. SEQ ID NO: 37, and is classified as of CHS, ASW, JPT, PUR or CHB ancestry then administering to said human a ligand that specifically binds said PCSK9 variant protein comprising a variant encoded by SEQ ID NO: 37.

21. The method of any one of paragraphs 1-19, wherein when said human is determined to comprise and/or selected as comprising:

a. PCSK9 protein form f, and is classified as of ASW, YRI, GBR, TSI, CLM, LWK, MXL, JPT, PUR, IBS, FIN or CEU ancestry then administering a ligand that specifically binds said PCSK9 protein form f for a time and in an amount effective to treat and/or prevent said disease or condition in said human, thereby to treat and/or prevent said disease or condition in said human; or
b. PCSK9 protein form c, and is classified as of ASW, YRI, GBR, TSI, CLM, CHB, LWK, CHS, JPT, PUR, FIN or CEU ancestry then administering a ligand that specifically binds said PCSK9 protein form c for a time and in an amount effective to treat and/or prevent said disease or condition in said human, thereby to treat and/or prevent said disease or condition in said human; or
c. PCSK9 protein form p, and is classified as of ASW, GBR, TSI, CLM, JPT, PUR, IBS, FIN or CEU ancestry then administering a ligand that specifically binds said PCSK9 protein form p for a time and in an amount effective to treat and/or prevent said disease or condition in said human, thereby to treat and/or prevent said disease or condition in said human; or
d. PCSK9 protein form m, and is classified as of LWK, ASW, YRI or CLM ancestry then administering a ligand that specifically binds said PCSK9 protein form m for a time and in an amount effective to treat and/or prevent said disease or condition in said human, thereby to treat and/or prevent said disease or condition in said human; or
e. PCSK9 protein form e, and is classified as of LWK, ASW or YRI ancestry then administering a ligand that specifically binds said PCSK9 protein form e for a time and in an amount effective to treat and/or prevent said disease or condition in said human, thereby to treat and/or prevent said disease or condition in said human; or
f. PCSK9 protein form h, and is classified as of PUR, TSI, FIN or CEU ancestry then administering a ligand that specifically binds said PCSK9 protein form h for a time and in an amount effective to treat and/or prevent said disease or condition in said human, thereby to treat and/or prevent said disease or condition in said human; or
g. PCSK9 protein form aj, and is classified as of LWK, ASW or YRI ancestry then administering a ligand that specifically binds said PCSK9 protein form aj for a time and in an amount effective to treat and/or prevent said disease or condition in said human, thereby to treat and/or prevent said disease or condition in said human; or
h. PCSK9 protein form q, and is classified as of CHS, ASW, JPT, PUR or CHB ancestry then administering a ligand that specifically binds said PCSK9 protein form q for a time and in an amount effective to treat and/or

prevent said disease or condition in said human, thereby to treat and/or prevent said disease or condition in said human.

22. The method of any one of paragraphs 1-21, wherein said ligand is capable of specifically binding said PCSK9 variant protein or a nucleic acid encoding said PCSK9 variant protein.
23. The method of any one of paragraphs 1-21, wherein said ligand specifically binds two or more human PCSK9 variant proteins or fragment thereof selected from the group consisting of SEQ ID NOs: 4-27.
24. The method of paragraph 23, wherein said ligand specifically binds two or more human PCSK9 proteins or fragment thereof, wherein at least one of the protein fragments comprise an amino acid sequence selected from SEQ ID NOs: 4-14, 18-23, 26 and 27.
25. The method of any one of paragraphs 4 and 6-23, wherein said human PCSK9 protein assayed in said sample is in the mature form.
26. The method of any one of paragraphs 4 and 6-24, wherein said human PCSK9 protein assayed in said sample is in the pro-form.
27. The method of paragraph 1-26, wherein said disease or condition is selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia; dyslipidemia; hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication, type II diabetes, high blood pressure, and a cardiovascular disease or condition.
28. A kit for genotyping a proprotein convertase subtilisin/kexin type 9 (PCSK9) gene variant in a nucleic acid sample of a human being affected with or at risk of a PCSK9 mediated disease, the kit comprising

a. at least one nucleic acid probe comprising a sequence of at least 10 contiguous nucleotides that can specifically hybridize to and identify in a biological sample the presence of a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 and the sequence thereof encoding a catalytic domain- or C-terminal domain of a PCSK9 protein, or can specifically hybridize to and identify in a biological sample the presence of an antisense of said nucleotide sequence, wherein said nucleic acid probe hybridizes to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or an antisense sequence thereof; and/or
b. at least two nucleic acid probes comprising at least two sequences, each of at least 10 contiguous nucleotides of a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or comprising an antisense sequence of said contiguous nucleotides, wherein at least one of said oligonucleotide probes comprises at least one nucleotide present in said selected nucleotide sequence which is not present in SEQ ID NO: 28 or an antisense sequence thereof, and
c. optionally at least one of the following: one or more buffers, packaging, label, and/or instructions for PCSK9 genotyping in a biological sample comprising nucleic acids obtained from a human.

29. The kit of paragraph 28, wherein the nucleic acid probe is attached to a solid surface.
30. The kit of any of paragraphs 28-29, further comprising a detectable label attached to said nucleic acid probe.
31. A kit for phenotyping proprotein convertase subtilisin/kexin type 9 (PCSK9) protein in a biological sample, the kit comprising a plurality of antibodies or antibody portions or fragments, wherein each antibody or antibody fragment or portion is specific for a PCSK9 variant protein selected from the group consisting of forms f, c, r, p, m, e, h, aj and q or a catalytic or C-terminal domain or a peptide thereof that comprises amino acid variation from the corresponding sequence of SEQ ID NO: 1, 2 or 3; and optionally at least one of the following: one or more buffers, packaging and/or label or instructions or a label for PCSK9 phenotyping in a biological sample comprising PCSK9 obtained from a human.
32. The kit of paragraph 31, further comprising a statin.
33. A pharmaceutical composition comprising a ligand capable of specifically binding proprotein convertase subtilisin/kexin type 9 (PCSK9) variants selected from the group consisting of forms f, c, r, p, m, e, h, aj and q or a catalytic or C-terminal domain or a peptide thereof that comprises amino acid variation from the corresponding sequence of SEQ ID NO: 1, 2 or 3.
34. The pharmaceutical composition of paragraph 33, wherein the ligand is an antibody, antibody portion, antibody fragment or an affibody specific for the PCSK9 variant selected from the group consisting of forms f, c, r, p, m, e, h, aj and q or a catalytic or C-terminal domain or a peptide thereof that comprises amino acid variation from the corresponding sequence of SEQ ID NO: 1, 2 or 3.
35. The pharmaceutical composition of any of paragraphs 33-34, further comprising a statin.
36. The pharmaceutical composition of paragraph 35, wherein the statin is atorvastatin.
37. A drug delivery system comprising the pharmaceutical composition of paragraph 33 or 34 and an injection or IV device.

38. A kit comprising the pharmaceutical composition of paragraph 33, packaging and instructions or label for administering the ligand to a human affected with or at risk of a PCSK9-mediated disease or condition, wherein the human expresses a variant PCSK9 protein form selected from the group consisting of forms f, c, r, p, m, e, h, aj and q or a catalytic or C-terminal domain or a peptide thereof.
39. The kit of paragraph 38, wherein the instructions or label indicate administration with a statin and/or to a human who is indicated for statin treatment or has been administered a statin or has reduced responsiveness to statin treatment.
40. The kit of paragraph 38 or 39, wherein the human has been determined to be and/or selected as resistant to treatment with statins.
41. The kit of paragraph 39 or 40, wherein the instructions or label indicate administration to a human who has received statin and further instruct reducing statin administration to the human.
42. The kit of paragraph 38, further comprising at least one buffer, packaging and/or instructions or label for PCSK9 genotyping in a biological sample obtained from a human.
43. The kit of paragraph 38 wherein the label comprises a marketing authorization number issued by a regulatory agency.
44. The kit of paragraph 43, wherein the regulatory agency is selected from the FDA or EMA.
45. The kit of paragraph 38, wherein the label or instructions further comprise directions to administer alirocumab or evolocumab to said human.
46. The kit of any one of paragraphs 38-45, further comprising an IV or injection device that optionally comprises alirocumab or evolocumab.
47. A kit for treating and/or preventing a disease or condition mediated by proprotein convertase subtilisin/kexin type 9 (PCSK9) in a human who has been determined to comprise and/or selected as comprising a PCSK9 variant protein the kit comprising (a) a alirocumab or evolocumab in a sealed container, and (b) a label or instructions indicating administration of the alirocumab or evolocumab to a human who expresses a variant PCSK9 protein form selected from the group consisting of forms f, c, r, p, m, e, h, aj and q or a catalytic or C-terminal domain or a peptide thereof.
48. The kit of paragraph 47, wherein the label further indicates that if the human has been or is administered statin, the statin treatment should be continued.
49. The kit of paragraph 47, wherein the label further indicates that if the human has been or is administered statin, the statin treatment should be reduced or discontinued.
50. A method of treating and/or preventing a disease or condition mediated by proprotein convertase subtilisin/kexin type 9 (PCSK9) in a human, the method comprising

a. assaying a biological sample from the human for the presence of one or more PCSK9 protein variants selected from the group consisting of PCSK9 forms f, c, r, p, m, e, h, aj and q; and
b. administering a therapeutically effective amount of a human PCSK9 binding ligand to the human when one or more of the PCSK9 forms f, c, r, p, m, e, h, aj and q is detected.

51. The method of paragraph 50, wherein the ligand specifically binds one or more of the PCSK9 forms f, c, r, p, m, e, h, aj and q.
52. A method of treating and/or preventing a disease or condition mediated by proprotein convertase subtilisin/kexin type 9 (PCSK9) in a human, the method comprising

a. assaying a biological sample from the human for the presence or one or more PSCK9 nucleic acid variants selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof; and
b. administering a therapeutically effective amount of a human PCSK9 binding ligand to the human when one or more of the PCSK9 nucleic acid variants are detected.

53. The method of paragraph 52, wherein the ligand specifically binds one or more of the PCSK9 forms f, c, r, p, m, e, h, aj and q.
54. A method of selecting a human for treatment and/or prevention of a disease mediated by a proprotein convertase subtilisin/kexin type 9 (PCSK9) protein with a human PCSK9 binding ligand comprising:

a. assaying a biological sample taken from the human for the presence of a PCSK9 protein variant selected from the group consisting of forms f, c, r, p, m, e, h, aj and q, and
b. selecting the human for treatment with the human PCSK9 binding ligand when at least one of the PCSK9 protein variants selected from the group consisting of forms f, c, r, p, m, e, h, aj and q is detected.

55. The method of paragraph 54, wherein the human is indicated for statin treatment or has been administered statin.
56. The method of paragraph 54 or 55, wherein the human has been identified as substantially resistant to statin treatment or has reduced responsiveness to statin treatment.
57. The method of any one of paragraphs 54-56, wherein the disease or condition is selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia; dyslipidemia; hypercholesterolemia, heart attack, stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication, type II diabetes, high blood pressure, and a cardiovascular disease or condition.
58. The method of any one of paragraphs 54-57, wherein the administered human PCSK9 binding ligand is specific for the detected PCSK9 form.
59. The method of any one of paragraphs 54-58, wherein said PCSK9 protein form comprises an amino acid sequence selected from the group consisting of SEQ ID NOs: 4-27.
60. The method of any one of paragraphs 54-59, wherein said PCSK9 protein form comprises the mature PCSK9 form.
61. An assay for selecting a human affected with a proprotein convertase subtilisin/kexin type 9 (PCSK9) protein mediated disease or condition as eligible for treatment with human PCSK9 binding ligand, the method comprising

a. contacting a biological sample from said human with at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides that can specifically hybridize to and identify in the biological sample a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof, or that specifically hybridizes to an antisense of said sequence, wherein said nucleic acid hybridizes to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridizes to an antisense sequence thereby forming a complex when at least one nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof is present; and/or
b. detecting the presence or absence of the complex; and
c. selecting the human as eligible for treatment with the human PCSK9 binding ligand when presence of at least one complex comprising a PCSK9 form encoded by SEQ ID NOs: 29-37 or the catalytic domain- or C-terminal domain-encoding sequence thereof is detected.

62. An assay for selecting a human as eligible for treatment with human proprotein convertase subtilisin/kexin type 9 (PCSK9) binding ligand, the method comprising

a. contacting a biological sample from a human with PCSK9 mediated disease or condition with one or more antibody, antibody portion or antibody fragment capable of binding to a PCSK9 variant form selected from the group consisting of PCSK9 form f, c, r, p, m, e, h, aj and q thereby forming a complex when one or more PCSK9 form f, c, r, p, m, e, h, aj and q is present;
b. detecting the presence or absence or the complex; and
c. selecting the human as eligible for treatment with the human PCSK9 binding ligand when presence of at least one complex comprising PCSK9 form f, c, r, p, m, e, h, aj and q is detected.

63. The assay of paragraphs 61 or 62, wherein the disease or condition is selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia; dyslipidemia; hypercholesterolemia, heart attack, stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication, type II diabetes, high blood pressure, and a cardiovascular disease or condition.
64. The assay of any one of paragraphs 61-63, wherein the human PSCK9 binding ligand is specific for the detected PCSK9 form.
65. The assay of any one of paragraphs 61-64, further comprising amplifying nucleic acids from the biological sample.
66. The assay of any one of paragraphs 61-65, further comprising isolating nucleic acids from the biological sample.
67. The assay of any one of paragraphs 61-66, further comprising administering to said human the PCSK9-binding ligand.
68. A method of producing an anti-human proprotein convertase subtilisin/kexin type 9 (PCSK9) antibody binding site, the method comprising obtaining a plurality of anti-PCSK9 antibody binding sites, screening the antibody binding sites for binding to a human PCSK9 selected from the group consisting of forms f, c, r, p, m, e, h, aj and q or a catalytic or C-terminal domain or a peptide thereof that comprises amino acid variation from the corresponding sequence of SEQ ID NO: 1, 2 or 3 and isolating an antibody binding site that binds in the screening step, and optionally producing a form f, c, r, p, m, e, h, aj or q PCSK9-binding fragment or derivative of the isolated antibody.
69. A method of producing an anti-human proprotein convertase subtilisin/kexin type 9 (PCSK9) antibody, the method comprising immunising a non-human vertebrate with a human PCSK9 comprising an amino acid sequence selected from the group consisting of the amino acid sequences of forms f, c, r, p, m, e, h, aj and q or a catalytic or C-terminal

domain or a peptide thereof that comprises amino acid variation from the corresponding sequence of SEQ ID NO: 1, 2 or 3 and isolating an antibody that binds a human PCSK9 comprising selected from the group consisting of forms f, c, r, p, m, e, h, aj and q or a catalytic or C-terminal domain or a peptide thereof that comprises amino acid variation from the corresponding sequence of SEQ ID NO: 1, 2 or 3, and optionally producing a form f, c, r, p, m, e, h, aj or q PCSK9-binding fragment or derivative of the isolated antibody.

70. The method of paragraphs 68-69, wherein the non-human vertebrate is a mouse or a rat.

71. The method of any of paragraphs 68-70, comprising the step of obtaining a nucleic acid encoding the antibody, fragment, derivative or binding site and optionally inserting the nucleic acid in an expression vector.

72. A kit for proprotein convertase subtilisin/kexin type 9 (PCSK9) genotyping a human, wherein the kit comprises a nucleic acid (i) comprising a sequence of contiguous nucleotides that specifically hybridises to a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof, or specifically hybridises to an antisense sequence or an RNA transcript of said sequence, wherein said sequence of contiguous nucleotides hybridises to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridises to an antisense sequence or an RNA transcript thereof; and/or (ii) comprising a sequence of at least 10 contiguous nucleotides of a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or comprising an antisense sequence or RNA version of said contiguous nucleotides, wherein said sequence of contiguous nucleotides comprises at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28.

73. A kit for proprotein convertase subtilisin/kexin type 9 (PCSK9) genotyping or phenotyping a human, wherein the kit comprises a ligand antibody that binds a human PCSK9 comprising selected from the group consisting of forms f, c, r, p, m, e, h, aj and q or a catalytic or C-terminal domain or a peptide thereof that comprises amino acid variation from the corresponding sequence of SEQ ID NO: 1, 2 or 3, or an antibody, fragment or derivative produced by the method of any one of paragraphs 68-71.

74. A method of targeting a proprotein convertase subtilisin/kexin type 9 (PCSK9) for treating and/or preventing a PCSK9-mediated disease or condition in a human, the method comprising administering an anti-PCSK9 ligand to a human comprising a nucleotide sequence selected from the group consisting SEQ ID NOs: 29-37, whereby a PCSK9 encoded by said nucleotide sequence is targeted.

75. The method of paragraph 74, wherein the method comprises targeting a human PCSK9 selected from the group consisting of forms f, c, r, p, m, e, h, aj and q with said ligand to treat and/or prevent said disease or condition in said human.

76. A method of treating and/or preventing a disease or condition mediated by proprotein convertase subtilisin/kexin type 9 (PCSK9) in a human, the method comprising targeting a human PCSK9 selected from the group consisting of forms f, c, r, p, m, e, h, aj and q by administering to the human a ligand that binds said PCSK9 thereby treating and/or preventing said disease or condition in the human.

77. The method of paragraph 76, wherein the genome of the human comprises a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37.

78. The method of any one of paragraphs 74 to 77, wherein the human has been or is genotyped as positive for a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or the catalytic- or C-terminal domain-encoding sequence thereof.

79. The method of any one of paragraphs 74 to 78, wherein the human has been or is phenotyped as positive for a human PCSK9 selected from the group consisting of forms f, c, r, p, m, e, h, aj and q.

80. The method of any one of paragraphs 74-79, wherein the method comprises genotyping the human as positive for a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or the catalytic- or C-terminal domain-encoding sequence thereof.

81. The method of any one of paragraphs 74-80, wherein the method comprises phenotyping the human as positive for a human PCSK9 sequence selected from the group consisting of forms f, c, r, p, m, e, h, aj and q.

82. The method of any one of paragraphs 74 to 81, wherein the human has been or is genotyped as heterozygous for a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or the catalytic- or C-terminal domain-encoding sequence thereof; optionally wherein the human has been or is genotyped as comprising the nucleotide sequence of SEQ ID NO: 28 or the catalytic- or C-terminal domain-encoding sequence thereof and a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or the catalytic- or C-terminal domain-encoding sequence thereof.

83. The method of any one of paragraphs 74 to 82, wherein the genome of the human has been or is genotyped as homozygous for a nucleotide sequence selected from the group consisting of of SEQ ID NOs: 29-37 or the catalytic- or C-terminal domain-encoding sequence thereof.

84. The method of any one of paragraphs 74 to 83, wherein the method comprises genotyping the human for a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or the catalytic- or C-terminal domain-encoding sequence thereof before administering the ligand to the human, wherein the ligand is determined to be

capable of binding to a PCSK9 encoded by said selected sequence.

85. The method according to any one of paragraphs 74 to 84 further comprising administering said ligand and a statin (eg, atorvastatin) to the human.

86. The method of paragraph 85, wherein the ligand and statin are administered separately.

87. The method of paragraph 85, wherein the ligand and statin are administered simultaneously.

88. The method of any one of paragraphs 74 to 87, wherein the ligand is administered by subcutaneous injection.

89. A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof comprising

a. selecting a human comprising (i) a proprotein convertase subtilisin/kexin type 9 (PCSK9) nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37; and/or (ii) a nucleotide sequence thereof encoding the catalytic domain or C-terminal domain of a PCSK9 protein; and

b. administering to said human an antibody or antibody fragment that specifically binds one or more a PCSK9 amino acid sequence encoded by said nucleotide sequence comprised by the human.

90. The method of paragraph 89, wherein step (a) comprises selecting a human comprising a PCSK9 protein encoded by the nucleotide sequence of (i) or (ii).

91. The method of paragraph 89 or 90, wherein the antibody or antibody fragment specifically binds said PCSK9 amino acid sequence.

92. The method of paragraph 89 or 90, wherein the antibody or antibody fragment binds a second PCSK9 protein comprising an amino acid sequence encoded by (i) a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37; and/or (ii) a nucleotide sequence thereof encoding the catalytic domain or C-terminal domain of a PCSK9 protein.

93. The method of paragraph 89 or 90, wherein the antibody comprises a VH domain derived from the recombination of a human VH gene segment, human D gene segments and a human JH segment, the VH gene segment comprising a nucleotide sequence that comprises a single nucleotide polymorphism with nucleotide C as indicated in rs56069819 (SEQ ID NO 41).

94. The method of paragraph 93, wherein the VH gene segment is VH3-23*04.

95. The method of any one of paragraphs 89-93, wherein the antibody comprises a VH domain, wherein the VH domain comprises the framework 1 sequence of SEQ ID NO: 38.

96. The method of any one of paragraphs 89-95, wherein the human has been determined to comprise the nucleotide sequence of (i) and/or (ii).

97. The method of any one of paragraphs 89-96, wherein the human has been determined to comprise a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein encoded by the nucleotide sequence of (i) and/or (ii).

The method of any one of paragraphs 89-97, comprising the step of determining that the human comprises the nucleotide sequence of (i) and/or (ii).

98. The method of paragraph 98, wherein the determining step is performed before administration of the antibody to the human.

99. The method of any one of paragraphs 89-99, comprising the step of determining that the human comprises a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein encoded by the nucleotide sequence of (i) and/or (ii).

100. The method of paragraph 100, wherein the determining step is performed before administration of the antibody to the human.

101. The method of paragraph 100 or 101, wherein the step of determining comprises assaying a biological sample from the human for (i) a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37; and/or (ii) a nucleotide sequence encoding the catalytic domain or C-terminal domain of the PCSK9 variant protein.

102. The method of paragraph 102, wherein the assaying comprises contacting the biological sample with

a. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides that can specifically hybridize to and identify in the biological sample a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof, or that specifically hybridizes to an antisense of said sequence, wherein said nucleic acid hybridizes to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridizes to an antisense sequence thereby forming a complex when at least one nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or at least the catalytic domain- or C-terminal domain-encoding sequence thereof is present; and/or

b. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides of a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 or comprising an antisense sequence of

said contiguous nucleotides, wherein said sequence of contiguous nucleotides comprises at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 thereby forming a complex when a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 is present; and

detecting the presence or absence of the complex, wherein detecting the presence of the complex determines that the human comprises the PCSK9 variant protein.

103. The method of paragraph 102 or 103, wherein the assaying comprises nucleic acid amplification and optionally one or more methods selected from sequencing, next generation sequencing, nucleic acid hybridization, and allele-specific amplification.

104. The method of any one of paragraphs 102-104, wherein the assaying is performed in a multiplex format.

105. The method of any one of paragraphs 102-105, further comprising obtaining the biological sample from the human.

106. The method of any one of paragraphs 89-106, wherein said human is or has been further determined to be substantially resistant to statin treatment.

107. The method of any one of paragraphs 89-107, wherein the human is receiving or has received statin treatment or has reduced responsiveness to statin treatment.

108. The method of any one of paragraphs 89-108, wherein the human is further administered a statin.

109. The method of any one of paragraphs 89-108, wherein said antibody or antibody fragment and said statin are administered separately or simultaneously.

110. The method of any one of paragraphs 106-110, wherein said biological sample comprises serum, blood, feces, tissue, a cell, urine and/or saliva of said human.

111. The method of any one of paragraphs 89-111, wherein said human is indicated as heterozygous for a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 and/or the nucleotide sequence thereof encoding the catalytic domain- or C-terminal domain-encoding sequence of a PCSK9 protein.

112. The method of any one of paragraphs 89-112, wherein said human is further indicated as comprising the nucleotide sequence of SEQ ID NO: 28 and/or the catalytic domain- or C-terminal domain-encoding sequence thereof.

113. The method of any one of paragraphs 89-113, wherein said human is indicated as homozygous for a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29-37 and/or the catalytic domain- or C-terminal domain-encoding sequence thereof.

114. The method of any one of paragraphs 89-114, wherein said human has been diagnosed with at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia; dyslipidemia; hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication, type II diabetes, high blood pressure, and a cardiovascular disease or condition.

115. The method of any one of paragraphs 89-115, wherein said method treats or prevents in said human at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia; dyslipidemia; hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication, type II diabetes, high blood pressure, and a cardiovascular disease or condition.

Additional Tailoring of Ligands to Genotype and/or Phenotype of the Human Patient

[0586] As described herein, the present invention contemplates ligands (eg, antibodies and fragments) whose binding site specificities have been matched to one or more variant human PCSK9s. Human PCSK9 is referred to as "TOI" elsewhere herein. Additionally or alternatively (and as further illustrated in the non-limiting Examples below), an optional aspect of the invention provides for matching of other features of the ligand to the patient's genotype or phenotype. In this respect, for example, the invention includes the ability to match amino acid sequence variation in a human patient to one or more ligand sequences or domains outside of the binding sites. For example, where the ligand comprises or consists of a human PCSK9-binding antibody or an anti-human PCSK9 receptor Fc fusion, this aspect of the invention provides for more tailored matching of one or more constant region domains (eg, the Fc) to the patient genotype or phenotype. Additionally or alternatively, it is contemplated that sequence variation in the binding site can be similarly matched to the patient's genotype or phenotype. The present inventor has done this by considering the SNP occurrences in sequences encoding one or more parts of the ligand, eg, SNP occurrences in one, more or all of the gene segments from which the variable domain(s) and/or constant region domain(s) are derived. The inventor realised that it would be desirable to match the ligand to one or more corresponding variant SNPs found in the patient to be treated therapeutically and/or prophylactically. Matching could involve designing the ligand specifically for a patient of known phenotype and/or genotype, or matching could involve choosing a ligand by determining that there is correspondence between variation in the patient's phenotype or genotype with the variation in the ligand amino acid and/or corresponding nucleotides.

[0587] A key consideration for the inventor was the desire to promote compatibility of the ligand with the patient's

body, and in particular, the possible patient immune system responses to administered ligands. For example, it has been observed that human patients receiving human or humanised antibody drugs may mount an immune response against the incoming antibody (a so-called HAHA response) which results in the patient producing anti-drug antibodies as a result of the patient's immune system recognising the drug as foreign. For example, studies have suggested that some patients receiving HUMIRA™ (adalimumab), currently the biggest selling antibody medicine, mount a HAHA immune response against the medicine, and this may impact treatment adversely. Reference is made to JAMA. 2011;305(14):1460-1468. doi:10.1001/jama.2011.406: "Development of Antidrug Antibodies Against Adalimumab and Association With Disease Activity and Treatment Failure During Long-term Follow-up", GM Bartelds *et al.* The authors concluded that results of this study showed that development of antidrug antibodies was associated with a negative outcome of adalimumab treatment in human RA patients. It was reported that not only did patients with anti-adalimumab antibodies discontinue treatment more often and earlier than patients without anti-adalimumab antibodies, they also had a higher disease activity during treatment and only rarely came into remission. In addition, reportedly the data showed that two-thirds of the anti-adalimumab antibody-positive patients developed these antibodies in the first 28 weeks of treatment and that the presence of anti-adalimumab antibodies substantially influenced serum adalimumab concentrations.

[0588] This HAHA theme is, therefore, a significant concern and this has been considered by the regulatory authorities. For example, the European Medicines Agency (EMA) has issued a "Guideline on immunogenicity assessment of monoclonal antibodies intended for *in vivo* clinical use" (available on the world wide web at ema.europa.eu/docs/en_GB/document_library/Scientific_guideline/2012/06/WC500128688.pdf; EMA/CHMP/BMWP/86289/2010, addendum to EMEA/CHMP/BMWP/14327/2006), which came into force on 1st December 2012. As such, it is good practice for researchers to identify and assess risk of anti-antibody drug occurrence and effects.

[0589] The present aspect of the invention, by more closely tailoring the ligand itself (as well as its specificity) to the patient, helps to address these considerations when designing and administering anti-human PCSK9 medicines for treating and/or preventing human PCSK9-related diseases and conditions.

[0590] The inventor also considered the desirability to tailor the variation in the ligand constant region (eg, for an antibody or Fc-containing ligand), mindful that then the constant region being administered to the patient would be tuned to the various components, such as patient's Fc receptors, that would interact with the constant region in the patient. Good Fc/Fc receptor interactions can be important for drug recycling (via the FcRn) to provide for useful half-lives *in vivo* or for use in cell killing, eg, for cancer indications. In this way it is possible, therefore, to tune the effector function of the constant region (eg, Fc) to the patient more closely, to promote efficacy. For example, more efficacious drugs are desirable for better patient treatment and may provide the possibility of lowered dosing and/or dosing frequencies.

[0591] Thus, in examples of this aspect, the invention provides the following (set out as clauses):-

1. The ligand, method, use, kit or composition of the invention, wherein

   (i) the ligand (eg, antibody or fragment) comprises

      (a) a variable domain that is encoded by a human V region nucleotide sequence, wherein the V nucleotide sequence is derived from recombination of human VH, D and JH gene segments or human VL and JL gene segments; or
      (b) a constant region domain encoded by a C region gene segment;
      Wherein a first gene segment of said gene segments of (a), or said C region gene segment of (b) comprises a first single nucleotide polymorphism (SNP) encoding a first amino acid polymorphism; and

   (ii) the genome of said human comprises said first SNP or wherein said human expresses (a') an antibody variable domain comprising said first amino acid polymorphism or (b') an antibody constant domain comprising said first amino acid polymorphism.

2. The ligand, method, use, kit or composition of clause 1, wherein blood of said human comprises substantially no antibodies that specifically bind to the domain comprising said first amino acid polymorphism as determined in an *in vitro* binding assay.

3. The ligand, method, use, kit or composition of clause 2, wherein SPR is used to carry out said assay. In an alternative, ELISA is used.

4. The ligand, method, use, kit or composition of any one of clauses 1 to 3, wherein the genome of said human comprises said first gene segment (when (a) applies) or said C region gene segment (when (b) applies).

5. The ligand, method, use, kit or composition of any one of clauses 1 to 4, wherein said first segment or a second segment of said segments of (a), or said C region gene segment of (b), comprises a second SNP encoding a second amino acid polymorphism; and wherein the genome of said human comprises said second SNP or wherein said human expresses (a") an antibody variable domain comprising said second amino acid polymorphism or (b") an antibody constant region domain comprising said first and second amino acid polymorphisms.

6. The ligand, method, use, kit or composition of clause 5, wherein said human expresses an antibody variable domain comprising said first and second amino acid polymorphisms.

7. The ligand, method, use, kit or composition of clause 5 or 6, wherein the first and second SNPs of said genome are comprised by the same antibody gene segment.
For example, the first and second SNPs of the genome are comprised by an IGHG1*01 gene segment and said first segment of (a) is an IGHG1*01 gene segment.
For example, the first and second SNPs of the genome are comprised by an IGHG2*01 gene segment and said first segment of (a) is an IGHG2*01 gene segment.

8. The ligand, method, use, kit or composition of any one of clauses 1 to 7, wherein each SNP is a variable region gene segment SNP.

9. The ligand, method, use, kit or composition of any one of clauses 1 to 7, wherein each SNP is a constant region gene segment SNP, eg each SNP is a gamma-1 constant region gene segment SNP, or a gamma-2 constant region gene segment SNP, or a gamma-3 constant region gene segment SNP or a gamma-4 constant region gene segment SNP.

10. The ligand, method, use, kit or composition of clause 9, wherein the first SNP is a CH1, CH2, CH3 or CH4 gene segment SNP and/or the second SNP is a CH1, CH2, CH3 or CH4 gene segment SNP.

11. The ligand, method, use, kit or composition of any one of clauses 1 to 8, wherein each SNP is a variable domain SNP, eg, a VH domain SNP, or a Vκ domain SNP, or a Vλ SNP.

12. The ligand, method, use, kit or composition of any one of clauses 1 to 11, wherein said constant region domain of (b) is comprised by an antibody Fc region.

13. The ligand, method, use, kit or composition of any one of clauses 1 to 12, wherein the ligand (eg, antibody or fragment) has been determined to specifically bind one or more human PCSK9 variants as disclosed herein, for example, with a KD of 1nM or less (eg, 100 or 10pM or less) as determined by SPR.

14. The ligand, method, use, kit or composition of the invention (eg, according to any one of clauses 1 to 13), wherein the ligand comprises or consists of an antibody or fragment that comprises a human antibody variable domain derived from the recombination of a human V gene segment and a human J gene segment (and optionally a human D gene segment when the variable domains are VH domains); and wherein the genome of the human comprises said human V gene segment and/or the human expresses antibodies comprising antibody variable domains derived from the recombination of said human V gene segment and a human J gene segment (and optionally a human D gene segment).
In an example, the V gene segment is any of the V gene segments disclosed in WO2013041844, a 1000 Genomes database and/or www.imgt.org, the disclosures of which (including disclosure relating to sequence) is explicitly incorporated herein by reference for use in the present invention.

15. The ligand, method, use, kit or composition of the invention (eg, according to any one of clauses 1 to 14), wherein the ligand (eg, comprising or consisting of an antibody or fragment or an Fc-fused human PCSK9 receptor) comprises a human heavy chain constant domain encoded by a first constant region nucleotide sequence; and wherein the genome of the human comprises a heavy chain constant region nucleotide sequence that is identical to said first constant region nucleotide sequence and/or the human expresses antibodies comprising said human constant domain.

16. The ligand, method, use, kit or composition of the invention (eg, according to any one of clauses 1 to 15), wherein the ligand (eg, comprising or consisting of an antibody or fragment or an Fc-fused human PCSK9 receptor) comprises a human gamma heavy chain CH1 domain encoded by a CH1 nucleotide sequence; and wherein the genome of

the human comprises a gamma heavy chain constant region nucleotide sequence that is identical to said CH1 nucleotide sequence and/or the human expresses antibodies comprising said human gamma CH1 domain.

17. The ligand, method, use, kit or composition of the invention (eg, according to any one of clauses 1 to 16), wherein the ligand (eg, comprising or consisting of an antibody or fragment or an Fc-fused human PCSK9 receptor) comprises a human gamma heavy chain CH2 domain encoded by a CH2 nucleotide sequence; and wherein the genome of the human comprises a gamma heavy chain constant region nucleotide sequence that is identical to said CH2 nucleotide sequence and/or the human expresses antibodies comprising said human gamma CH2 domain.

18. The ligand, method, use, kit or composition of the invention (eg, according to any one of clauses 1 to 17), wherein the ligand (eg, comprising or consisting of an antibody or fragment or an Fc-fused human PCSK9 receptor) comprises a human gamma heavy chain CH3 domain encoded by a CH3 nucleotide sequence; and wherein the genome of the human comprises a gamma heavy chain constant region nucleotide sequence that is identical to said CH3 nucleotide sequence and/or the human expresses antibodies comprising said human gamma CH3 domain.

19. The ligand, method, use, kit or composition of the invention (eg, according to any one of clauses 1 to 18), wherein the ligand (eg, comprising or consisting of an antibody or fragment or an Fc-fused human PCSK9 receptor) comprises a human gamma heavy chain CH4 domain encoded by a CH4 nucleotide sequence; and wherein the genome of the human comprises a gamma heavy chain constant region nucleotide sequence that is identical to said CH4 nucleotide sequence and/or the human expresses antibodies comprising said human gamma CH4 domain.

20. The ligand, method, use, kit or composition of the invention (eg, according to any one of clauses 1 to 19), wherein the ligand (eg, comprising or consisting of an antibody or fragment or an Fc-fused human PCSK9 receptor) comprises a human gamma heavy chain Fc region encoded by a Fc nucleotide sequence; and wherein the genome of the human comprises a gamma heavy chain constant region nucleotide sequence that is identical to said Fc nucleotide sequence and/or the human expresses antibodies comprising said human gamma Fc region.

21. The ligand, method, use, kit or composition of any one of clauses 16 to 20, wherein said human gamma heavy chain is a human gamma-1 heavy chain.

22. The ligand, method, use, kit or composition of any one of clauses 16 to 20, wherein said human gamma heavy chain is a human gamma-2 heavy chain.

23. The ligand, method, use, kit or composition of any one of clauses 16 to 20, wherein ligand comprises a human IGHG1*01 gamma-1 heavy chain constant region.

24. The ligand, method, use, kit or composition of any one of clauses 16 to 20, wherein ligand comprises a human IGHG2*01 gamma-1 heavy chain constant region.

25. The ligand, method, use, kit or composition of any one of clauses 15 to 24, wherein the human has been or is genotyped as positive for said heavy chain constant region nucleotide sequence.

26. The ligand, method, use, kit or composition of clause 23, wherein the human has been or is genotyped as positive for human IGHG1*01 nucleotide sequence.

27. The ligand, method, use, kit or composition of clause 24, wherein the human has been or is genotyped as positive for human IGHG2*01 nucleotide sequence.

28. The ligand, method, use, kit or composition of any one of clauses 16 to 24, wherein the human has been or is phenotyped as positive for said gamma heavy chain constant domain, CH1, CH2, CH3, CH4 or Fc.

29. The ligand, method, use, kit or composition of clause 28, (i) when dependent from clause 23, wherein the human has been or is phenotyped as positive for a human IGHG1*01 gamma heavy chain constant domain, CH1, CH2, CH3, CH4 or Fc or (ii) when dependent from clause 24, wherein the human has been phenotyped as positive for a human IGHG2*01 gamma heavy chain constant domain, CH1, CH2, CH3, CH4 or Fc.

30. The method or use of any one of clauses 16 to 24 and 26 to 29, comprising genotyping the human as positive for said gamma heavy chain constant region nucleotide sequence, eg, positive for said gamma heavy chain constant

domain, CH1, CH2, CH3, CH4 or Fc nucleotide sequence; positive for said human IGHG1*01 gamma heavy chain constant region, CH1, CH2, CH3, CH4 or Fc nucleotide sequence; or positive for said human IGHG2*01 gamma heavy chain constant region, CH1, CH2, CH3, CH4 or Fc nucleotide sequence.

31. The method or use of any one of clauses 16 to 24 and 26 to 30, comprising phenotyping the human as positive for said gamma heavy chain constant region, eg, positive for said gamma heavy chain constant domain, CH1, CH2, CH3, CH4 or Fc; positive for said human IGHG1*01 gamma heavy chain constant domain, CH1, CH2, CH3, CH4 or Fc; or positive for said human IGHG2*01 gamma heavy chain constant domain, CH1, CH2, CH3, CH4 or Fc.

Examples of Tailored Ligands

[0592] The inventor analysed amino acid variability and distribution amongst large representative human samples. The result of the analysis for example antibody gene segments is shown in Table 8.

[0593] In a first example, the inventor identified the possibility of addressing the rarer IGH-gamma-1 SNPs 204D (observed cumulative frequency of 0.296) and 206L (observed cumulative frequency of 0.283) individually or in combination. These residues are part of the CH3 domain, and as such they form part of antibody Fc regions. Thus, matching of these CH3 variations with the patient is especially beneficial for reasons as discussed above. Thus, this example provides aspects set out in the following clauses.

32. The ligand, method, use, kit or composition of the invention (eg, according to any one of clauses 1 to 31), wherein the ligand (eg, comprising or consisting of an antibody or fragment or an Fc-fused TOI receptor) comprises a human gamma-1 heavy chain constant region that comprises an Asp corresponding to position 204 of SEQ ID NO: 42 or a Leu corresponding to position 206 of SEQ ID NO: 42 and wherein the genome of the human comprises a gamma-1 heavy chain constant region nucleotide sequence that encodes such an Asp or Leu or the human expresses antibodies comprising human gamma-1 constant regions comprising such an Asp or Leu.
The skilled person will be familiar with techniques for determining genome sequences of a human, eg, by using a sample containing genomic DNA and/or RNA, sequencing and comparing using bioinformatics or other computer tools to compare the sampled sequence with sequences of human alleles (eg, as shown in the IMGT, 100 genomes or other database as disclosed herein). In an example, the sample is a blood or saliva or cheek swab sample.

33. The ligand, method, use, kit or composition of clause 32,wherein the ligand comprises a human gamma-1 heavy chain constant region that comprises an Asp corresponding to position 204 of SEQ ID NO: 42 and a Leu corresponding to position 206 of SEQ ID NO: 42.

34. The ligand, method, use, kit or composition of clause 32 or 33,wherein the genome of the human comprises a gamma-1 heavy chain constant region nucleotide sequence that encodes such an Asp and Leu or the human expresses antibodies comprising human gamma-1 constant regions comprising such an Asp and Leu.

35. The ligand, method, use, kit or composition of clause 32, 33 or 34, wherein the ligand comprises a human IGHG1*01 gamma-1 heavy chain constant region, eg, an Fc, CH1, CH2 and/or CH3 domain encoded by human IGHG1*01.

36. The ligand, method, use, kit or composition of any one of clauses 32 to 35, wherein the genome of the human comprises a human IGHG1*01 nucleotide sequence or the human expresses antibodies comprising human constant domains encoded by a human IGHG1*01 nucleotide sequence.

37. The ligand, method, use, kit or composition of any one of clauses 32 to 36, wherein the ligand comprises a hinge region encoded by human IGHG1*01.

38. The ligand, method, use, kit or composition of any one of clauses 32 to 37, wherein the ligand comprises or consists of an antibody, wherein the antibody comprises heavy chains that comprise SEQ ID NO: 61.

39. The ligand, method, use, kit or composition of any one of clauses 32 to 38, wherein the human is of European ancestry.
As shown in Table 8, 204D and 206L are found in such humans.

40. The ligand, method, use, kit or composition of any one of clauses 32 to 39, wherein the human has been or is genotyped as positive for said Asp and/or Leu.

41. The ligand, method, use, kit or composition of any one of clauses 32 to 40, wherein the human has been or is genotyped as positive for human IGHG1*01.

42. The ligand, method, use, kit or composition of any one of clauses 32 to 41, wherein the human has been or is phenotyped as positive for a human IGHG1*01 CH3.

43. The method or use of any one of clauses 32 to 42, comprising selecting a said human whose genome comprises a codon(s) encoding said Asp and/or Leu; comprises human IGHG1*01; or comprises a human IGHG1*01 CH3.

44. The method or use of any one of clauses 32 to 43, comprising selecting a said human whose phenotype comprises said Asp and/or Leu; a human IGHG1*01 region ; or a human IGHG1*01 CH3.
44a. The ligand, method, use, kit or composition of any one of clauses 32 to 44, wherein the human expresses antibodies comprising human gamma-1 constant regions comprising such an Asp and Leu.

[0594] In a second example, the inventor identified the possibility of addressing IGH-gamma-2 SNPs. This included consideration of Fc region variation - in this respect, the inventor focused on positions 161 and 257 which are in the Fc region. Thus, this example provides aspects set out in the following clauses.

45. The ligand, method, use, kit or composition of the invention (eg, according to any one of clauses 1 to 31), wherein the ligand (eg, comprising or consisting of an antibody or fragment or an Fc-fused TOI receptor) comprises a human gamma-2 heavy chain constant region that comprises an amino acid selected from the group consisting of a Pro corresponding to position 72 of SEQ ID NO: 44, an Asn corresponding to position 75 of SEQ ID NO: 44, a Phe corresponding to position 76 of SEQ ID NO: 44, a Val corresponding to position 161 of SEQ ID NO: 44 and an Ala corresponding to position 257 of SEQ ID NO: 44; and wherein the genome of the human comprises a gamma-2 heavy chain constant region nucleotide sequence that encodes such a selected amino acid or the human expresses antibodies comprising human gamma-2 constant regions comprising such a selected amino acid.

46. The ligand, method, use, kit or composition of clause 45, wherein the ligand comprises a human gamma-2 heavy chain constant region that comprises (i) a Pro corresponding to position 72 of SEQ ID NO: 44, an Asn corresponding to position 75 of SEQ ID NO: 44, a Phe corresponding to position 76 of SEQ ID NO: 44 and optionally (ii) a Val corresponding to position 161 of SEQ ID NO: 44 and/or an Ala corresponding to position 257 of SEQ ID NO: 44; and wherein the genome of the human comprises a gamma-2 heavy chain constant region nucleotide sequence that encodes such amino acids of (i) or the human expresses antibodies comprising human gamma-2 constant regions comprising such amino acids of (i).
This example focuses on CH1 variation.

47. The ligand, method, use, kit or composition of clause 45 or 46, wherein the ligand comprises a human gamma-2 heavy chain constant region that comprises (i) a Val corresponding to position 161 of SEQ ID NO: 44 and an Ala corresponding to position 257 of SEQ ID NO: 44 and optionally (ii) an amino acid selected from the group consisting of a Pro corresponding to position 72 of SEQ ID NO: 44, an Asn corresponding to position 75 of SEQ ID NO: 44 and a Phe corresponding to position 76 of SEQ ID NO: 44; and wherein the genome of the human comprises a gamma-2 heavy chain constant region nucleotide sequence that encodes such amino acids of (i) or the human expresses antibodies comprising human gamma-2 constant regions comprising such amino acids of (i).
This example focuses on Fc variation.

48. The ligand, method, use, kit or composition of any one of clauses 45 to 47, wherein the ligand comprises a human IGHG2*01 gamma-2 heavy chain constant region, eg, an Fc, CH1, CH2 and/or CH3 domain encoded by human IGHG2*01.

49. The ligand, method, use, kit or composition of any one of clauses 45 to 48, wherein the genome of the human comprises a human IGHG2*01 nucleotide sequence or the human expresses antibodies comprising human constant domains encoded by a human IGHG2*01 nucleotide sequence.

50. The ligand, method, use, kit or composition of any one of clauses 45 to 49, wherein the ligand comprises a hinge region encoded by human IGHG2*01.

51. The ligand, method, use, kit or composition of any one of clauses 45 to 50, wherein the ligand comprises or consists of an antibody, wherein the antibody comprises heavy chains that comprise SEQ ID NO: 63 or 65.

52. The ligand, method, use, kit or composition of any one of clauses 45 to 51, wherein the human is of European, African American, or European American ancestry.

53. The ligand, method, use, kit or composition of any one of clauses 45 to 52, wherein the human has been or is genotyped as positive for one, more or all of said Pro, Asn, Phe, Val and Ala.

54. The ligand, method, use, kit or composition of any one of clauses 45 to 53, wherein the human has been or is genotyped as positive for human IGHG2*01.

55. The ligand, method, use, kit or composition of any one of clauses 45 to 54, wherein the human has been or is phenotyped as positive for a human IGHG2*01 CH1.

56. The ligand, method, use, kit or composition of any one of clauses 45 to 55, wherein the human has been or is phenotyped as positive for a human IGHG2*01 CH2.

57. The ligand, method, use, kit or composition of any one of clauses 45 to 56, wherein the human has been or is phenotyped as positive for a human IGHG2*01 CH3.

58. The method or use of any one of clauses 45 to 57, comprising selecting a said human whose genome comprises a codon(s) encoding one, more or all of said Pro, Asn, Phe, Val and Ala; comprises human IGHG2*01; or comprises a human IGHG2*01 CH1, CH2 and/or CH3.

59. The method or use of any one of clauses 45 to 58, comprising selecting a said human whose phenotype comprises one, more or all of said Pro, Asn, Phe, Val and Ala; a human IGHG2*01 region; or a human IGHG2*01 CH1, CH2 and/or CH3.

60. The ligand, method, use, kit or composition of any one of clauses 45 to 59, wherein the human expresses antibodies comprising human gamma-2 constant regions comprising such a Pro, Asn, Phe, Val and Ala.

[0595] In a third example, the inventor addressed human kappa constant region variation. Thus, the present aspect of the invention also provides the following.

61. The ligand, method, use, kit or composition of the invention (eg, according to any one of clauses 1 to 60), wherein the ligand (eg, comprising or consisting of an antibody or fragment or an Fc-fused TOI receptor) comprises a human kappa light chain constant region that comprises a Val corresponding to position 84 of SEQ ID NO: 50 or a Cys corresponding to position 87 of SEQ ID NO: 50; and wherein the genome of the human comprises a kappa light chain constant region nucleotide sequence that encodes such a Val or Cys or the human expresses antibodies comprising human kappa light chain constant regions comprising such a Val or Cys.

62. The ligand, method, use, kit or composition of clause 61, wherein the ligand comprises a human kappa light chain constant region that comprises a Val corresponding to position 84 of SEQ ID NO: 50 and a Cys corresponding to position 87 of SEQ ID NO: 50.

63. The ligand, method, use, kit or composition of clause 61 or 62, wherein the genome of the human comprises a kappa light chain constant region nucleotide sequence that encodes such a Val and Cys or the human expresses antibodies comprising human kappa constant regions comprising such a Val and Cys.

64. The ligand, method, use, kit or composition of any one of clauses 61 to 63, wherein the antibody or fragment comprises a human IGKC*01 kappa light chain constant region.

65. The ligand, method, use, kit or composition of any one of clauses 61 to 64, wherein the ligand comprises or consists of an antibody, wherein the antibody comprises light chains that comprise SEQ ID NO: 62 or 66.

66. The ligand, method, use, kit or composition of any one of clauses 61 to 65, wherein the ligand comprises or consists of an antibody, wherein the antibody comprises a light chain variable domain derived from recombination of a human Vκ gene segment and a human Jκ gene segment, wherein the Jκ gene segment is IGKJ2*01 (SEQ ID NO: 57).

67. The ligand, method, use, kit or composition of any one of clauses 61 to 66, wherein the human has been or is phenotyped as positive for said Val and/or Cys.

68. The ligand, method, use, kit or composition of any one of clauses 61 to 67, wherein the human has been or is genotyped as positive for human IGKC*01.

69. The ligand, method, use, kit or composition of any one of clauses 61 to 68, wherein the human has been or is phenotyped as positive for a human IGKC*01 domain.

70. The method or use of any one of clauses 61 to 69, comprising selecting a said human whose genome comprises a codon(s) encoding said Val and/or Cys; or comprises human IGKC*01.

71. The method or use of any one of clauses 61 to 70, comprising selecting a said human whose phenotype comprises such a Val and/or Cys; or comprises a human IGKC*01 domain.

72. The ligand, method, use, kit or composition of any one of clauses 61 to 71, wherein the human expresses antibodies comprising human kappa constant domains comprising such a Val and Cys, eg, expresses human IGKC*01 constant domains.

[0596] In a fourth example, the inventor addressed human lambda constant region variation. Thus, this example provides aspects set out in the following clauses.

73. The ligand, method, use, kit or composition of the invention (eg, according to any one of clauses 1 to 60), wherein the ligand (eg, comprising or consisting of an antibody or fragment or an Fc-fused TOI receptor) comprises a human IGLC2*01 light chain constant region; and wherein the genome of the human comprises a human IGLC2*01 nucleotide sequence or the human expresses antibodies comprising human light chain IGLC2*01 constant regions.

74. The ligand, method, use, kit or composition of clause 73, wherein the antibody comprises light chains that comprise SEQ ID NO: 64.

75. The ligand, method, use, kit or composition of clause 73 or 74, wherein the human has been or is genotyped as positive for human IGLC2*01.

76. The ligand, method, use, kit or composition of any one of clauses 73 to 75, wherein the human has been or is phenotyped as positive for a human IGLC2*01 domain.

77. The method or use of any one of clauses 73 to 76, comprising selecting a said human whose genome comprises human IGLC2*01.

78. The method or use of any one of clauses 73 to 77, comprising selecting a said human whose phenotype comprises a human IGLC2*01 domain.

79. The ligand, method, use, kit or composition of any one of clauses 73 to 78, wherein the human expresses antibodies comprising human lambda IGLC2*01 constant domains.

[0597] In a fifth example, the inventor addressed human heavy chain variable region variation. Thus, this example provides aspects set out in the following clauses.

80. The ligand, method, use, kit or composition of the invention (eg, according to any one of clauses 1 to 79), wherein the ligand comprises or consists of an antibody or fragment, wherein the antibody or fragment comprises a VH domain that is derived from the recombination of a human VH gene segment, a human D gene segment and a human JH gene segment, wherein the VH gene segment is selected from the group consisting of (i) IGHV1-18*01 and the genome of the human comprises a human IGHV1-18*01 nucleotide sequence or the human expresses antibodies comprising variable domains derived from the recombination of human IGHV1-18*01; or (ii) IGVH1-46*01 and the genome of the human comprises a human IGHV1-46*01 nucleotide sequence or the human expresses antibodies comprising variable domains derived from the recombination of human IGHV1-46*01.

81. The ligand, method, use, kit or composition of clause 80, wherein the antibody or fragment comprises a one

more or all of a CH1 domain, CH2 domain, CH3 domain, hinge or Fc encoded by human IGHG2*01.

82. The ligand, method, use, kit or composition of clause 80 or 81, wherein the antibody or fragment comprises heavy chains that comprise SEQ ID NO: 63 or 65.

83. The ligand, method, use, kit or composition of any one of clauses 80 to 82, wherein the human has been or is genotyped as positive for said selected VH gene segment, positive for human IGHV1-18*01 or IGVH1-46*01.

84. The method or use of any of clauses 80 to 83, comprising genotyping the human as positive for said selected VH gene segment, eg, positive for human IGHV1-18*01 or IGVH1-46*01.

[0598] In a sixth example, the inventor addressed human light chain variable region variation. Thus, this example provides aspects set out in the following clauses.

85. The ligand, method, use, kit or composition of the invention (eg, according to any one of clauses 1 to 84), wherein the ligand comprises or consists of an antibody or fragment, wherein the antibody or fragment comprises a VL domain that is derived from the recombination of a human VL gene segment and a human JL gene segment, wherein the VL gene segment is selected from the group consisting of (i) IGKV4-1*01 and the genome of the human comprises a human IGKV4-1*01 nucleotide sequence or the human expresses antibodies comprising variable domains derived from the recombination of human IGKV4-1*01; (ii) IGLV2-14*01 and the genome of the human comprises a human IGLV2-14*01 nucleotide sequence or the human expresses antibodies comprising variable domains derived from the recombination of human IGLV2-14*01; or (iii) IGKV1-13*02 and the genome of the human comprises a human IGKV1-13*02 nucleotide sequence or the human expresses antibodies comprising variable domains derived from the recombination of human IGKV1-13*02.

86. The ligand, method, use, kit or composition of clause 85, wherein the antibody comprises light chains that comprise SEQ ID NO: 62, 64 or 66.

87. The ligand, method, use, kit or composition of clause 85 or 86, wherein the antibody or fragment comprises a light chain variable domain derived from recombination of a human Vκ gene segment and a human Jκ gene segment, wherein the Jκ gene segment is IGKJ2*01 (SEQ ID NO: 57; wherein (i) or (iii) applies.

88. The ligand, method, use, kit or composition of any one of clauses 85 to 87, wherein the human has been or is genotyped as positive for said selected VL gene segment, eg, positive for human IGKV4-1*01, IGLV2-14*01 or IGKV1-13*02.

89. The method or use of clause 88, comprising genotyping the human as positive for said selected VL gene segment, eg, genotyping the human as positive for human IGKV4-1*01, IGLV2-14*01 or IGKV1-13*02.

90. The ligand, method, use, kit or composition of any one of clauses 1 to 89, wherein the ligand (eg, antibody or fragment) binds said human PCSK9 with a dissociation constant (Kd) of 1nM or less as determined by SPR, (eg, 100, 10 or 1pM or less).

[0599] Further exemplary ligands are in the paragraphs 1-17 as follows.

1. An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody or fragment comprises a human gamma heavy chain constant region that comprises a first amino acid that is encoded by a human gamma heavy chain constant region gene segment SNP, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation I474V or E670G in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said PCSK9 amino acid sequence and comprises a human gamma heavy chain constant region gene segment comprising said SNP, or the human expresses antibodies comprising human gamma constant regions comprising said first amino acid.

[0600] In an alternative, paragraph 1 provides:-
An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody or fragment comprises a human gamma-1 heavy chain constant region that comprises an Asp corresponding to position 204 of SEQ ID NO: 42 or a Leu corresponding

to position 206 of SEQ ID NO: 42, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation I474V or E670G in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said amino acid sequence and comprises an IGHG1*01 human heavy chain constant region gene segment, or the human expresses antibodies comprising human gamma-1 constant regions comprising such an Asp and Leu.

[0601] In an embodiment, said mutation is I474V. In another embodiment, said mutation is E670G.

[0602] An example provides:-

An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody or fragment comprises a human gamma-1 heavy chain constant region that comprises an Asp corresponding to position 204 of SEQ ID NO: 42 and a Leu corresponding to position 206 of SEQ ID NO: 42, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation I474V in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said amino acid sequence and comprises an IGHG1*01 human heavy chain constant region gene segment. Optionally, the antibody or fragment comprises an IGHG1*01 human heavy chain constant region.

[0603] Another example provides:-

An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody or fragment comprises a human gamma-1 heavy chain constant region that comprises an Asp corresponding to position 204 of SEQ ID NO: 42 and a Leu corresponding to position 206 of SEQ ID NO: 42, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation E670G in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said amino acid sequence and comprises an IGHG1*01 human heavy chain constant region gene segment. Optionally, the antibody or fragment comprises an IGHG1*01 human heavy chain constant region.

[0604] In an example, said antibody or antibody fragment has been determined to specifically bind a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 or E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human gamma-1 heavy chain constant region that comprises an Asp corresponding to position 204 of SEQ ID NO: 42 and a Leu corresponding to position 206 of SEQ ID NO: 42 and wherein said human comprises (i) an IGHG1*01 human heavy chain constant region gene segment and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1.

2. The antibody or antibody fragment of paragraph 1, wherein the antibody comprises a human gamma-1 heavy chain constant region that comprises an Asp corresponding to position 204 of SEQ ID NO: 42 and a Leu corresponding to position 206 of SEQ ID NO: 42.

3. The antibody or antibody fragment of paragraph 1 or 2, wherein the antibody comprises an IGHG1*01 human heavy chain constant region.

4. The antibody or antibody fragment of any one of paragraphs 1 to 3, wherein the human has been determined to comprise the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1 and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein encoded by the nucleotide sequence of SEQ ID NO: 29 or 30.

5. The antibody or antibody fragment of any one of paragraphs 1 to 4, the method comprising the step of determining that the human comprises the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein comprising said mutation I474V or E670G, optionally, wherein the determining step is performed before administration of the antibody to the human.

6. The antibody or antibody fragment of paragraph 5, wherein the step of determining comprises assaying a biological sample from the human for a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

7. The antibody or antibody fragment of paragraph 6, wherein the assaying comprises contacting the biological sample with

a. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides that can

specifically hybridize to and identify in the biological sample a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or that specifically hybridizes to an antisense of said sequence, wherein said nucleic acid hybridizes to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridizes to an antisense sequence thereby forming a complex when at least one nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and/or

b. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides of a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or comprising an antisense sequence of said contiguous nucleotides, wherein said sequence of contiguous nucleotides comprises at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 thereby forming a complex when the nucleotide sequence encoding the PCSK9 that comprises a C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and

detecting the presence or absence of the complex, wherein detecting the presence of the complex determines that the human comprises the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

8. The antibody or antibody fragment of paragraph 6 or 7, wherein the assaying comprises nucleic acid amplification and optionally one or more methods selected from sequencing, next generation sequencing, nucleic acid hybridization, and allele-specific amplification and/or wherein the assaying is performed in a multiplex format.

9. The antibody or antibody fragment of any one of paragraphs 1 to 8, wherein said antibody or antibody fragment is for administration to a human that is or has been further determined to be substantially resistant to statin treatment.

10. The antibody or antibody fragment of any one of paragraphs 1 to 9, wherein antibody or antibody fragment is for administration to a human that is receiving or has received statin treatment or has reduced responsiveness to statin treatment.

11. The antibody or antibody fragment of paragraph 9 or 10, wherein said antibody or antibody fragment is for administration to the human separately or simultaneously with said statin treatment.

12. The antibody or antibody fragment of any one of paragraphs 6 to 10, wherein said biological sample comprises serum, blood, faeces, tissue, a cell, urine and/or saliva of said human.

13. The antibody or antibody fragment of any one of paragraphs 1 to 12, wherein said human is indicated as heterozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising a mutation I474V or E670G, optionally, wherein said human is further indicated as comprising the nucleotide sequence of SEQ ID NO: 28, or said human is indicated as homozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising a mutation I474Vor E670G in SEQ ID NO: 1.

14. The antibody or antibody fragment of any one of paragraphs 1 to 13, wherein said human has been diagnosed with at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

15. The antibody or antibody fragment of any one of paragraphs 1 to 14, wherein said antibody or antibody fragment treats or reduces the risk in said human of at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

16. The antibody or antibody fragment of any one of paragraphs 1 to 15, wherein the nucleotide sequence is SEQ ID NO: 29 or 30.

17. The antibody or antibody fragment of any one of paragraphs 1 to 16, wherein said antibody or antibody fragment is for administration by intravenous or subcutaneous administration and/or is comprised in an injectable preparation.

[0605] Further exemplary methods are in the paragraphs 1-18 as follows.

1. A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 or E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human gamma-1 heavy chain constant region that comprises an Asp corresponding to position 204 of SEQ ID NO: 42 or a Leu corresponding to position 206 of SEQ ID NO: 42 and wherein said human comprises (i) an IGHG1*01 human heavy chain constant region gene segment, or the human expresses antibodies comprising human gamma-1 heavy chain constant regions comprising such an Asp and Leu and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1.

[0606] In an embodiment, said mutation is I474V. In another embodiment, said mutation is E670G.

[0607] An example provides:-

A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 in SEQ ID NO: 1, wherein the antibody or fragment comprises a human gamma-1 heavy chain constant region that comprises an Asp corresponding to position 204 of SEQ ID NO: 42 and a Leu corresponding to position 206 of SEQ ID NO: 42 and wherein said human comprises (i) an IGHG1*01 human heavy chain constant region gene segment and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V in SEQ ID NO: 1. Optionally, the antibody or fragment comprises a IGHG1*01 human heavy chain constant region.

[0608] Another example provides:-

A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human gamma-1 heavy chain constant region that comprises an Asp corresponding to position 204 of SEQ ID NO: 42 and a Leu corresponding to position 206 of SEQ ID NO: 42 and wherein said human comprises (i) an IGHG1*01 human heavy chain constant region gene segment and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation E670G in SEQ ID NO: 1. Optionally, the antibody or fragment comprises an IGHG1*01 human heavy chain constant region.

[0609] In an example, said antibody or antibody fragment has been determined to specifically bind a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 or E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human gamma-1 heavy chain constant region that comprises an Asp corresponding to position 204 of SEQ ID NO: 42 and a Leu corresponding to position 206 of SEQ ID NO: 42 and wherein said human comprises (i) an IGHG1*01 human heavy chain constant region gene segment and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1.

2. The method of paragraph 1, comprising, before said administering, selecting a human comprising said nucleotide sequence of (ii), wherein the human is the human of paragraph 1.

3. The method of paragraph 1 or 2, wherein the antibody comprises a human gamma-1 heavy chain constant region that comprises an Asp corresponding to position 204 of SEQ ID NO: 42 and a Leu corresponding to position 206 of SEQ ID NO: 42.

4. The method of paragraph 1, 2 or 3, wherein the antibody comprises an IGHG1*01 human heavy chain constant region.

5. The method of any one of paragraphs 1 to 4, wherein the human has been determined to comprise the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1 and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein encoded by the nucleotide sequence of SEQ ID NO: 29 or 30.

6. The method of any one of paragraphs 1 to 5, comprising the step of determining that the human comprises the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein comprising said mutation I474V or E670G, optionally, wherein the determining step is performed before administration of the antibody to the

human.

7. The method of paragraph 6, wherein the step of determining comprises assaying a biological sample from the human for a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

8. The method of paragraph 7, wherein the assaying comprises contacting the biological sample with

a. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides that can specifically hybridize to and identify in the biological sample a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or that specifically hybridizes to an antisense of said sequence, wherein said nucleic acid hybridizes to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridizes to an antisense sequence thereby forming a complex when at least one nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and/or

b. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides of a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or comprising an antisense sequence of said contiguous nucleotides, wherein said sequence of contiguous nucleotides comprises at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 thereby forming a complex when the nucleotide sequence encoding the PCSK9 that comprises a C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and

detecting the presence or absence of the complex, wherein detecting the presence of the complex determines that the human comprises the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

9. The method of paragraph 7 or 8, wherein the assaying comprises nucleic acid amplification and optionally one or more methods selected from sequencing, next generation sequencing, nucleic acid hybridization, and allele-specific amplification and/or wherein the assaying is performed in a multiplex format.

10. The method of any one of paragraphs 1 to 9, wherein said human is or has been further determined to be substantially resistant to statin treatment.

11. The method of any one of paragraphs 1 to 10, wherein said human is receiving or has received statin treatment or has reduced responsiveness to statin treatment.

12. The method of paragraph 10 or 11, wherein said antibody or antibody fragment is administered to the human separately or simultaneously with said statin treatment.

13. The method of any one of paragraphs 7 to 9, wherein said biological sample comprises serum, blood, faeces, tissue, a cell, urine and/or saliva of said human.

14. The method of any one of paragraphs 1 to 13, wherein said human is indicated as heterozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising said mutation I474V or E670G, optionally, wherein said human is further indicated as comprising the nucleotide sequence of SEQ ID NO: 28, or said human is indicated as homozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising said mutation I474Vor E670G in SEQ ID NO: 1.

15. The method of any one of paragraphs 1 to 14, wherein said human has been diagnosed with at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

16. The method of any one of paragraphs 1 to 15, wherein said antibody or antibody fragment treats or reduces the risk in said human of at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

17. The method of any one of paragraphs 1 to 16, wherein the nucleotide sequence is SEQ ID NO: 29 or 30.

18. The method of any one of paragraphs 1 to 17, wherein said antibody or antibody fragment is administered by intravenous or subcutaneous administration and/or is comprised in an injectable preparation.

[0610] Further exemplary ligands are in the paragraphs 1-17 as follows.

1. An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody comprises a human gamma-2 heavy chain constant region that comprises an amino acid selected from the group consisting of a Pro corresponding to position 72 of SEQ ID NO: 44, an Asn corresponding to position 75 of SEQ ID NO: 44, a Phe corresponding to position 76 of SEQ ID NO: 44, a Val corresponding to position 161 of SEQ ID NO: 44 and an Ala corresponding to position 257 of SEQ ID NO: 44, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation I474V or E670G in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said amino acid sequence and comprises an IGHG2*01 human heavy chain constant region gene segment, or the human expresses antibodies comprising human gamma-2 constant regions comprising such a Pro, Asn, Phe, Val and Ala.

[0611] In an embodiment, said mutation is I474V. In another embodiment, said mutation is E670G.

[0612] An example provides:-

An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody comprises a human gamma-2 heavy chain constant region that comprises a Pro corresponding to position 72 of SEQ ID NO: 44, an Asn corresponding to position 75 of SEQ ID NO: 44, a Phe corresponding to position 76 of SEQ ID NO: 44, a Val corresponding to position 161 of SEQ ID NO: 44 and an Ala corresponding to position 257 of SEQ ID NO: 44, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation I474V in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said amino acid sequence and comprises an IGHG2*01 human heavy chain constant region gene segment. Optionally, the antibody or fragment comprises an IGHG2*01 human heavy chain constant region.

[0613] Another example provides:-

An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody comprises a human gamma-2 heavy chain constant region that comprises a Pro corresponding to position 72 of SEQ ID NO: 44, an Asn corresponding to position 75 of SEQ ID NO: 44, a Phe corresponding to position 76 of SEQ ID NO: 44, a Val corresponding to position 161 of SEQ ID NO: 44 and an Ala corresponding to position 257 of SEQ ID NO: 44, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation E670G in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said amino acid sequence and comprises an IGHG2*01 human heavy chain constant region gene segment. Optionally, the antibody or fragment comprises an IGHG2*01 human heavy chain constant region.

[0614] In an example, said antibody or antibody fragment has been determined to specifically bind a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 or E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human gamma-2 heavy chain constant region that comprises a Pro corresponding to position 72 of SEQ ID NO: 44, an Asn corresponding to position 75 of SEQ ID NO: 44, a Phe corresponding to position 76 of SEQ ID NO: 44, a Val corresponding to position 161 of SEQ ID NO: 44 and an Ala corresponding to position 257 of SEQ ID NO: 44 and wherein said human comprises (i) an IGHG2*01 human heavy chain constant region gene segment and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1.

2. The antibody or antibody fragment of paragraph 1, wherein the antibody comprises a human gamma-2 heavy chain constant region that comprises a Pro corresponding to position 72 of SEQ ID NO: 44, an Asn corresponding to position 75 of SEQ ID NO: 44, a Phe corresponding to position 76 of SEQ ID NO: 44, a Val corresponding to position 161 of SEQ ID NO: 44 and an Ala corresponding to position 257 of SEQ ID NO: 44.

3. The antibody or antibody fragment of paragraph 1 or 2, wherein the antibody comprises an IGHG2*01 human heavy chain constant region.

4. The antibody or antibody fragment of any one of paragraphs 1 to 3, wherein the human has been determined to comprise the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation

I474V or E670G in SEQ ID NO: 1 and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein encoded by the nucleotide sequence of SEQ ID NO: 29 or 30.

5. The antibody or antibody fragment of any one of paragraphs 1 to 4, the method comprising the step of determining that the human comprises the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein comprising said mutation I474V or E670G, optionally, wherein the determining step is performed before administration of the antibody to the human.

6. The antibody or antibody fragment of paragraph 5, wherein the step of determining comprises assaying a biological sample from the human for a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

7. The antibody or antibody fragment of paragraph 6, wherein the assaying comprises contacting the biological sample with

a. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides that can specifically hybridize to and identify in the biological sample a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or that specifically hybridizes to an antisense of said sequence, wherein said nucleic acid hybridizes to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridizes to an antisense sequence thereby forming a complex when at least one nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and/or

b. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides of a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or comprising an antisense sequence of said contiguous nucleotides, wherein said sequence of contiguous nucleotides comprises at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 thereby forming a complex when the nucleotide sequence encoding the PCSK9 that comprises a C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and

detecting the presence or absence of the complex, wherein detecting the presence of the complex determines that the human comprises the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

8. The antibody or antibody fragment of paragraph 6 or 7, wherein the assaying comprises nucleic acid amplification and optionally one or more methods selected from sequencing, next generation sequencing, nucleic acid hybridization, and allele-specific amplification and/or wherein the assaying is performed in a multiplex format.

9. The antibody or antibody fragment of any one of paragraphs 1 to 8, wherein said antibody or antibody fragment is for administration to a human that is or has been further determined to be substantially resistant to statin treatment.

10. The antibody or antibody fragment of any one of paragraphs 1 to 9, wherein antibody or antibody fragment is for administration to a human that is receiving or has received statin treatment or has reduced responsiveness to statin treatment.

11. The antibody or antibody fragment of paragraph 9 or 10, wherein said antibody or antibody fragment is for administration to the human separately or simultaneously with said statin treatment.

12. The antibody or antibody fragment of any one of paragraphs 6 to 8, wherein said biological sample comprises serum, blood, faeces, tissue, a cell, urine and/or saliva of said human.

13. The antibody or antibody fragment of any one of paragraphs 1 to 12, wherein said human is indicated as heterozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising a mutation I474V or E670G, optionally, wherein said human is further indicated as comprising the nucleotide sequence of SEQ ID NO: 28, or said human is indicated as homozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising a mutation I474Vor E670G in SEQ ID NO: 1.

14. The antibody or antibody fragment of any one of paragraphs 1 to 13, wherein said human has been diagnosed with at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

15. The antibody or antibody fragment of any one of paragraphs 1 to 14, wherein said antibody or antibody fragment treats or reduces the risk in said human of at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

16. The antibody or antibody fragment of any one of paragraphs 1 to 15, wherein the nucleotide sequence is SEQ ID NO: 29 or 30.

17. The antibody or antibody fragment of any one of paragraphs 1 to 16, wherein said antibody or antibody fragment is for administration by intravenous or subcutaneous administration and/or is comprised in an injectable preparation.

[0615] Further exemplary methods are in the paragraphs 1-18 as follows.

1. A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 or E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human gamma-2 heavy chain constant region that comprises an amino acid selected from the group consisting of a Pro corresponding to position 72 of SEQ ID NO: 44, an Asn corresponding to position 75 of SEQ ID NO: 44, a Phe corresponding to position 76 of SEQ ID NO: 44, a Val corresponding to position 161 of SEQ ID NO: 44 and an Ala corresponding to position 257 of SEQ ID NO: 44 and wherein said human comprises (i) an IGHG2*01 human heavy chain constant region gene segment, or the human expresses antibodies comprising human gamma-2 heavy chain constant regions comprising such a Pro, Asn, Phe, Val and Ala and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1.

[0616] In an embodiment, said mutation is I474V. In another embodiment, said mutation is E670G.

[0617] An example provides:-

A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 in SEQ ID NO: 1, wherein the antibody or fragment comprises a human gamma-2 heavy chain constant region that comprises a Pro corresponding to position 72 of SEQ ID NO: 44, an Asn corresponding to position 75 of SEQ ID NO: 44, a Phe corresponding to position 76 of SEQ ID NO: 44, a Val corresponding to position 161 of SEQ ID NO: 44 and an Ala corresponding to position 257 of SEQ ID NO: 44 and wherein said human comprises (i) an IGHG2*01 human heavy chain constant region gene segment and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V in SEQ ID NO: 1. Optionally, the antibody or fragment comprises an IGHG2*01 human heavy chain constant region.

[0618] Another example provides:-

A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human gamma-2 heavy chain constant region that comprises a Pro corresponding to position 72 of SEQ ID NO: 44, an Asn corresponding to position 75 of SEQ ID NO: 44, a Phe corresponding to position 76 of SEQ ID NO: 44, a Val corresponding to position 161 of SEQ ID NO: 44 and an Ala corresponding to position 257 of SEQ ID NO: 44 and wherein said human comprises (i) an IGHG2*01 human heavy chain constant region gene segment and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation E670G in SEQ ID NO: 1. Optionally, the antibody or fragment comprises an IGHG2*01 human heavy chain constant region.

[0619] In an example, said antibody or antibody fragment has been determined to specifically bind a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 or E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human gamma-2 heavy chain constant region that comprises a Pro corresponding to position 72 of SEQ ID NO: 44, an Asn corresponding to position 75 of SEQ ID NO: 44, a Phe corresponding to position 76 of SEQ ID NO: 44, a Val corresponding to position 161 of SEQ ID NO: 44 and an Ala

corresponding to position 257 of SEQ ID NO: 44 and wherein said human comprises (i) an IGHG2*01 human heavy chain constant region gene segment and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1.

2. The method of paragraph 1, comprising, before said administering, selecting said human comprising said nucleotide sequence of (ii).

3. The method of paragraph 1 or 2, wherein the antibody comprises a human gamma-1 heavy chain constant region that comprises a Pro corresponding to position 72 of SEQ ID NO: 44, an Asn corresponding to position 75 of SEQ ID NO: 44, a Phe corresponding to position 76 of SEQ ID NO: 44, a Val corresponding to position 161 of SEQ ID NO: 44 and an Ala corresponding to position 257 of SEQ ID NO: 44.

4. The method of paragraph 1, 2 or 3, wherein the antibody comprises an IGHG2*01 human heavy chain constant region.

5. The method of any one of paragraphs 1 to 4, wherein the human has been determined to comprise the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1 and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein encoded by the nucleotide sequence of SEQ ID NO: 29 or 30.

6. The method of any one of paragraphs 1 to 5, comprising the step of determining that the human comprises the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein comprising said mutation I474V or E670G, optionally, wherein the determining step is performed before administration of the antibody to the human.

7. The method of paragraph 6, wherein the step of determining comprises assaying a biological sample from the human for a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

8. The method of paragraph 7, wherein the assaying comprises contacting the biological sample with

a. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides that can specifically hybridize to and identify in the biological sample a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or that specifically hybridizes to an antisense of said sequence, wherein said nucleic acid hybridizes to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridizes to an antisense sequence thereby forming a complex when at least one nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and/or

b. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides of a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or comprising an antisense sequence of said contiguous nucleotides, wherein said sequence of contiguous nucleotides comprises at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 thereby forming a complex when the nucleotide sequence encoding the PCSK9 that comprises a C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and detecting the presence or absence of the complex, wherein detecting the presence of the complex determines that the human comprises the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

9. The method of paragraph 7 or 8, wherein the assaying comprises nucleic acid amplification and optionally one or more methods selected from sequencing, next generation sequencing, nucleic acid hybridization, and allele-specific amplification and/or wherein the assaying is performed in a multiplex format.

10. The method of any one of paragraphs 1 to 9, wherein said human is or has been further determined to be substantially resistant to statin treatment.

11. The method of any one of paragraphs 1 to 10, wherein said human is receiving or has received statin treatment

or has reduced responsiveness to statin treatment.

12. The method of paragraph 10 or 11, wherein said antibody or antibody fragment is administered to the human separately or simultaneously with said statin treatment.

13. The method of any one of paragraphs 7 to 9, wherein said biological sample comprises serum, blood, faeces, tissue, a cell, urine and/or saliva of said human.

14. The method of any one of paragraphs 1 to 13, wherein said human is indicated as heterozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising said mutation I474V or E670G, optionally, wherein said human is further indicated as comprising the nucleotide sequence of SEQ ID NO: 28, or said human is indicated as homozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising said mutation I474Vor E670G in SEQ ID NO: 1.

15. The method of any one of paragraphs 1 to 14, wherein said human has been diagnosed with at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

16. The method of any one of paragraphs 1 to 15, wherein said antibody or antibody fragment treats or reduces the risk in said human of at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

17. The method of any one of paragraphs 1 to 16, wherein the nucleotide sequence is SEQ ID NO: 29 or 30.

18. The method of any one of paragraphs 1 to 17, wherein said antibody or antibody fragment is administered by intravenous or subcutaneous administration and/or is comprised in an injectable preparation.

[0620] Further exemplary ligands are in the paragraphs 1-17 as follows.

1. An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody or fragment comprises a human kappa light chain constant region that comprises a Val corresponding to position 84 of SEQ ID NO: 50 or a Cys corresponding to position 87 of SEQ ID NO: 50, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation I474V or E670G in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said amino acid sequence and comprises an IGKC*01 human light chain constant region gene segment, or the human expresses antibodies comprising human kappa light chain constant regions comprising such an Val and Cys.

[0621] In an embodiment, said mutation is I474V. In another embodiment, said mutation is E670G.

[0622] An example provides:-

An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody or fragment comprises a human kappa light chain constant region that comprises a Val corresponding to position 84 of SEQ ID NO: 50 and a Cys corresponding to position 87 of SEQ ID NO: 50, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation I474V in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said amino acid sequence and comprises an IGKC*01 human light chain constant region gene segment. Optionally, the antibody or fragment comprises an IGKC*01 human light chain constant region.

[0623] Another example provides:-

An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody or fragment comprises a human kappa light chain constant region that comprises a Val corresponding to position 84 of SEQ ID NO: 50 and a Cys corresponding to position 87 of SEQ ID NO: 50, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation E670G in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said amino acid sequence and comprises an IGKC*01 human light chain constant region gene segment. Optionally, the antibody or fragment comprises an IGKC*01 human

light chain constant region.

[0624] In an example, said antibody or antibody fragment has been determined to specifically bind a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 or E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human kappa light chain constant region that comprises a Val corresponding to position 84 of SEQ ID NO: 50 and a Cys corresponding to position 87 of SEQ ID NO: 50 and wherein said human comprises (i) an IGKC*01 human heavy chain constant region gene segment and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1.

2. The antibody or antibody fragment of paragraph 1, wherein the antibody comprises a human kappa light chain constant region that comprises a Val corresponding to position 84 of SEQ ID NO: 50 or a Cys corresponding to position 87 of SEQ ID NO: 50.

3. The antibody or antibody fragment of paragraph 1 or 2, wherein the antibody comprises an IGKC*01 human kappa chain constant region.

4. The antibody or antibody fragment of any one of paragraphs 1 to 3, wherein the human has been determined to comprise the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1 and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein encoded by the nucleotide sequence of SEQ ID NO: 29 or 30.

5. The antibody or antibody fragment of any one of paragraphs 1 to 4, the method comprising the step of determining that the human comprises the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein comprising said mutation I474V or E670G, optionally, wherein the determining step is performed before administration of the antibody to the human.

6. The antibody or antibody fragment of paragraph 5, wherein the step of determining comprises assaying a biological sample from the human for a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

7. The antibody or antibody fragment of paragraph 6, wherein the assaying comprises contacting the biological sample with

a. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides that can specifically hybridize to and identify in the biological sample a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or that specifically hybridizes to an antisense of said sequence, wherein said nucleic acid hybridizes to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridizes to an antisense sequence thereby forming a complex when at least one nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and/or

b. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides of a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or comprising an antisense sequence of said contiguous nucleotides, wherein said sequence of contiguous nucleotides comprises at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 thereby forming a complex when the nucleotide sequence encoding the PCSK9 that comprises a C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and

detecting the presence or absence of the complex, wherein detecting the presence of the complex determines that the human comprises the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

8. The antibody or antibody fragment of paragraph 6 or 7, wherein the assaying comprises nucleic acid amplification and optionally one or more methods selected from sequencing, next generation sequencing, nucleic acid hybridization, and allele-specific amplification and/or wherein the assaying is performed in a multiplex format.

9. The antibody or antibody fragment of any one of paragraphs 1 to 8, wherein said antibody or antibody fragment

is for administration to a human that is or has been further determined to be substantially resistant to statin treatment.

10. The antibody or antibody fragment of any one of paragraphs 1 to 9, wherein antibody or antibody fragment is for administration to a human that is receiving or has received statin treatment or has reduced responsiveness to statin treatment.

11. The antibody or antibody fragment of paragraph 9 or 10, wherein said antibody or antibody fragment is for administration to the human separately or simultaneously with said statin treatment.

12. The antibody or antibody fragment of any one of paragraphs 6 to 10, wherein said biological sample comprises serum, blood, faeces, tissue, a cell, urine and/or saliva of said human.

13. The antibody or antibody fragment of any one of paragraphs 1 to 12, wherein said human is indicated as heterozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising a mutation I474V or E670G, optionally, wherein said human is further indicated as comprising the nucleotide sequence of SEQ ID NO: 28, or said human is indicated as homozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising a mutation I474Vor E670G in SEQ ID NO: 1.

14. The antibody or antibody fragment of any one of paragraphs 1 to 13, wherein said human has been diagnosed with at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

15. The antibody or antibody fragment of any one of paragraphs 1 to 14, wherein said antibody or antibody fragment treats or reduces the risk in said human of at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

16. The antibody or antibody fragment of any one of paragraphs 1 to 15, wherein the nucleotide sequence is SEQ ID NO: 29 or 30.

17. The antibody or antibody fragment of any one of paragraphs 1 to 16, wherein said antibody or antibody fragment is for administration by intravenous or subcutaneous administration and/or is comprised in an injectable preparation.

[0625] Further exemplary methods are in the paragraphs 1-18 as follows.

1. A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 or E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human kappa light chain constant region that comprises a Val corresponding to position 84 of SEQ ID NO: 50 or a Cys corresponding to position 87 of SEQ ID NO: 50 and wherein said human comprises (i) an IGKC*01 human light chain constant region gene segment, or the human expresses antibodies comprising human kappa light chain constant regions comprising such an Val and Cys and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1.

[0626] In an embodiment, said mutation is I474V. In another embodiment, said mutation is E670G.

[0627] An example provides:-

A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 in SEQ ID NO: 1, wherein the antibody or fragment comprises a human kappa light chain constant region that comprises a Val corresponding to position 84 of SEQ ID NO: 50 and a Cys corresponding to position 87 of SEQ ID NO: 50 and wherein said human comprises (i) an IGKC*01 human light chain constant region gene segment and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V in SEQ ID NO: 1. Optionally, the antibody or fragment comprises an IGKC*01 human light chain constant region.

[0628] Another example provides:-

A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human kappa light chain constant region that comprises a Val corresponding to position 84 of SEQ ID NO: 50 and a Cys corresponding to position 87 of SEQ ID NO: 50 and wherein said human comprises (i) an IGKC*01 human light chain constant region gene segment and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation E670G in SEQ ID NO: 1. Optionally, the antibody or fragment comprises an IGKC*01 human light chain constant region.

[0629] In an example, said antibody or antibody fragment has been determined to specifically bind a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 or E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human kappa light chain constant region that comprises a Val corresponding to position 84 of SEQ ID NO: 50 and a Cys corresponding to position 87 of SEQ ID NO: 50 and wherein said human comprises (i) an IGKC*01 human heavy chain constant region gene segment and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1.

2. The method of paragraph 1, comprising, before said administering, selecting said human comprising said nucleotide sequence of (ii).

3. The method of paragraph 1 or 2, wherein the antibody comprises a human kappa light chain constant region that comprises a Val corresponding to position 84 of SEQ ID NO: 50 or a Cys corresponding to position 87 of SEQ ID NO: 50.

4. The method of paragraph 1, 2 or 3, wherein the antibody comprises an IGKC*01 human kappa chain constant region.

5. The method of any one of paragraphs 1 to 4, wherein the human has been determined to comprise the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1 and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein encoded by the nucleotide sequence of SEQ ID NO: 29 or 30.

6. The method of any one of paragraphs 1 to 5, comprising the step of determining that the human comprises the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein comprising said mutation I474V or E670G, optionally, wherein the determining step is performed before administration of the antibody to the human.

7. The method of paragraph 6, wherein the step of determining comprises assaying a biological sample from the human for a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

8. The method of paragraph 7, wherein the assaying comprises contacting the biological sample with

a. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides that can specifically hybridize to and identify in the biological sample a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or that specifically hybridizes to an antisense of said sequence, wherein said nucleic acid hybridizes to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridizes to an antisense sequence thereby forming a complex when at least one nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and/or

b. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides of a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or comprising an antisense sequence of said contiguous nucleotides, wherein said sequence of contiguous nucleotides comprises at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 thereby forming a complex when the nucleotide sequence encoding the PCSK9 that comprises a C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and

detecting the presence or absence of the complex, wherein detecting the presence of the complex determines that the human comprises the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

9. The method of paragraph 7 or 8, wherein the assaying comprises nucleic acid amplification and optionally one or more methods selected from sequencing, next generation sequencing, nucleic acid hybridization, and allele-specific amplification and/or wherein the assaying is performed in a multiplex format.

10. The method of any one of paragraphs 1 to 9, wherein said human is or has been further determined to be substantially resistant to statin treatment.

11. The method of any one of paragraphs 1 to 10, wherein said human is receiving or has received statin treatment or has reduced responsiveness to statin treatment.

12. The method of paragraph 10 or 11, wherein said antibody or antibody fragment is administered to the human separately or simultaneously with said statin treatment.

13. The method of any one of paragraphs 7 to 9, wherein said biological sample comprises serum, blood, faeces, tissue, a cell, urine and/or saliva of said human.

14. The method of any one of paragraphs 1 to 13, wherein said human is indicated as heterozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising said mutation I474V or E670G, optionally, wherein said human is further indicated as comprising the nucleotide sequence of SEQ ID NO: 28, or said human is indicated as homozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising said mutation I474Vor E670G in SEQ ID NO: 1.

15. The method of any one of paragraphs 1 to 14, wherein said human has been diagnosed with at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

16. The method of any one of paragraphs 1 to 15, wherein said antibody or antibody fragment treats or reduces the risk in said human of at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

17. The method of any one of paragraphs 1 to 16, wherein the nucleotide sequence is SEQ ID NO: 29 or 30.

18. The method of any one of paragraphs 1 to 17, wherein said antibody or antibody fragment is administered by intravenous or subcutaneous administration and/or is comprised in an injectable preparation.

[0630] Further exemplary ligands are in the paragraphs 1-15 as follows.

1. An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody or fragment comprises a human IGLC2*01 lambda light chain constant region, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation I474V or E670G in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said amino acid sequence and comprises a human IGLC2*01 lambda light chain constant region gene segment, or the human expresses antibodies comprising human IGLC2*01 lambda light chain constant regions.

[0631] In an embodiment, said mutation is I474V. In another embodiment, said mutation is E670G.

[0632] An example provides:-

An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody or fragment comprises a human IGLC2*01 lambda light chain constant region, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation I474V in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said amino acid sequence and comprises a human

IGLC2*01 lambda light chain constant region gene segment. Optionally, the antibody or fragment comprises a human IGLC2*01 lambda light chain constant region.

[0633] Another example provides:-

An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody or fragment comprises a human IGLC2*01 lambda light chain constant region, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation E670G in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said amino acid sequence and comprises a human IGLC2*01 lambda light chain constant region gene segment. Optionally, the antibody or fragment comprises a human IGLC2*01 lambda light chain constant region.

[0634] In an example, said antibody or antibody fragment has been determined to specifically bind a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 or E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human IGLC2*01 lambda light chain constant region and wherein said human comprises (i) an IGLC2*01 human heavy chain constant region gene segment and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1.

2. The antibody or antibody fragment of paragraph 1, wherein the human has been determined to comprise the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1 and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein encoded by the nucleotide sequence of SEQ ID NO: 29 or 30.

3. The antibody or antibody fragment of paragraphs 1 or 2, the method comprising the step of determining that the human comprises the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein comprising said mutation I474V or E670G, optionally, wherein the determining step is performed before administration of the antibody to the human.

4. The antibody or antibody fragment of paragraph 3, wherein the step of determining comprises assaying a biological sample from the human for a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

5. The antibody or antibody fragment of paragraph 4, wherein the assaying comprises contacting the biological sample with

a. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides that can specifically hybridize to and identify in the biological sample a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or that specifically hybridizes to an antisense of said sequence, wherein said nucleic acid hybridizes to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridizes to an antisense sequence thereby forming a complex when at least one nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and/or

b. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides of a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or comprising an antisense sequence of said contiguous nucleotides, wherein said sequence of contiguous nucleotides comprises at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 thereby forming a complex when the nucleotide sequence encoding the PCSK9 that comprises a C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and

detecting the presence or absence of the complex, wherein detecting the presence of the complex determines that the human comprises the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

6. The antibody or antibody fragment of paragraph 4 or 5, wherein the assaying comprises nucleic acid amplification and optionally one or more methods selected from sequencing, next generation sequencing, nucleic acid hybridization, and allele-specific amplification and/or wherein the assaying is performed in a multiplex format.

7. The antibody or antibody fragment of any one of paragraphs 1 to 6, wherein said antibody or antibody fragment is for administration to a human that is or has been further determined to be substantially resistant to statin treatment.

8. The antibody or antibody fragment of any one of paragraphs 1 to 7, wherein antibody or antibody fragment is for administration to a human that is receiving or has received statin treatment or has reduced responsiveness to statin treatment.

9. The antibody or antibody fragment of paragraph 7 or 8, wherein said antibody or antibody fragment is for administration to the human separately or simultaneously with said statin treatment.

10. The antibody or antibody fragment of any one of paragraphs 4 to 8, wherein said biological sample comprises serum, blood, faeces, tissue, a cell, urine and/or saliva of said human.

11. The antibody or antibody fragment of any one of paragraphs 1 to 10, wherein said human is indicated as heterozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising a mutation I474V or E670G, optionally, wherein said human is further indicated as comprising the nucleotide sequence of SEQ ID NO: 28, or said human is indicated as homozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising a mutation I474Vor E670G in SEQ ID NO: 1.

12. The antibody or antibody fragment of any one of paragraphs 1 to 11, wherein said human has been diagnosed with at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

13. The antibody or antibody fragment of any one of paragraphs 1 to 12, wherein said antibody or antibody fragment treats or reduces the risk in said human of at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

14. The antibody or antibody fragment of any one of paragraphs 1 to 13, wherein the nucleotide sequence is SEQ ID NO: 29 or 30.

15. The antibody or antibody fragment of any one of paragraphs 1 to 14, wherein said antibody or antibody fragment is for administration by intravenous or subcutaneous administration and/or is comprised in an injectable preparation.

[0635] Further exemplary methods are in the paragraphs 1-16 as follows.

1. A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 or E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human IGLC2*01 lambda light chain constant region and wherein said human comprises (i) an IGLC2*01 human light chain constant region gene segment, or the human expresses antibodies comprising a human IGLC2*01 lambda light chain constant regions and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1.

[0636] In an embodiment, said mutation is I474V. In another embodiment, said mutation is E670G.

[0637] An example provides:-

A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 in SEQ ID NO: 1, wherein the antibody or fragment comprises a human IGLC2*01 lambda light chain constant region and wherein said human comprises (i) an IGLC2*01 human light chain constant region gene segment and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V in SEQ ID NO: 1. Optionally, the antibody or fragment comprises an IGLC2*01 human light chain constant region.

[0638] Another example provides:-

A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof,

the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human IGLC2*01 lambda light chain constant region and wherein said human comprises (i) an IGLC2*01 human light chain constant region gene segment and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation E670G in SEQ ID NO: 1. Optionally, the antibody or fragment comprises an IGLC2*01 human light chain constant region.

[0639] In an example, said antibody or antibody fragment has been determined to specifically bind a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 or E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human IGLC2*01 lambda light chain constant region and wherein said human comprises (i) an IGLC2*01 human heavy chain constant region gene segment and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1

2. The method of paragraph 1, comprising, before said administering, selecting said human comprising said nucleotide sequence of (ii).

3. The method of paragraph 1 or 2, wherein the human has been determined to comprise the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1 and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein encoded by the nucleotide sequence of SEQ ID NO: 29 or 30.

4. The method of any one of paragraphs 1 to 3, comprising the step of determining that the human comprises the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein comprising said mutation I474V or E670G, optionally, wherein the determining step is performed before administration of the antibody to the human.

5. The method of paragraph 4, wherein the step of determining comprises assaying a biological sample from the human for a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

6. The method of paragraph 5, wherein the assaying comprises contacting the biological sample with

a. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides that can specifically hybridize to and identify in the biological sample a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or that specifically hybridizes to an antisense of said sequence, wherein said nucleic acid hybridizes to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridizes to an antisense sequence thereby forming a complex when at least one nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and/or

b. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides of a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or comprising an antisense sequence of said contiguous nucleotides, wherein said sequence of contiguous nucleotides comprises at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 thereby forming a complex when the nucleotide sequence encoding the PCSK9 that comprises a C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and

detecting the presence or absence of the complex, wherein detecting the presence of the complex determines that the human comprises the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

7. The method of paragraph 5 or 6, wherein the assaying comprises nucleic acid amplification and optionally one or more methods selected from sequencing, next generation sequencing, nucleic acid hybridization, and allele-specific amplification and/or wherein the assaying is performed in a multiplex format.

8. The method of any one of paragraphs 1 to 7, wherein said human is or has been further determined to be

substantially resistant to statin treatment.

9. The method of any one of paragraphs 1 to 8, wherein said human is receiving or has received statin treatment or has reduced responsiveness to statin treatment.

10. The method of paragraph 8 or 9, wherein said antibody or antibody fragment is administered to the human separately or simultaneously with said statin treatment.

11. The method of any one of paragraphs 5 to 7, wherein said biological sample comprises serum, blood, faeces, tissue, a cell, urine and/or saliva of said human.

12. The method of any one of paragraphs 1 to 11, wherein said human is indicated as heterozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising said mutation I474V or E670G, optionally, wherein said human is further indicated as comprising the nucleotide sequence of SEQ ID NO: 28, or said human is indicated as homozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising said mutation I474Vor E670G in SEQ ID NO: 1.

13. The method of any one of paragraphs 1 to 12, wherein said human has been diagnosed with at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

14. The method of any one of paragraphs 1 to 13, wherein said antibody or antibody fragment treats or reduces the risk in said human of at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

15. The method of any one of paragraphs 1 to 14, wherein the nucleotide sequence is SEQ ID NO: 29 or 30.

16. The method of any one of paragraphs 1 to 15, wherein said antibody or antibody fragment is administered by intravenous or subcutaneous administration and/or is comprised in an injectable preparation.

[0640] Further exemplary ligands are in the paragraphs 1-15 as follows.

1. An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody or fragment comprises a human variable domain that is derived from the recombination of a human VH gene segment, a human D gene segment and a human JH gene segment, wherein the VH gene segment is as defined in any one of clauses 80 to 90, and the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) amino acid sequence that comprises a C-terminal domain comprising a mutation I474V or E670G in SEQ ID NO:1, wherein the human comprises a nucleotide sequence encoding said amino acid sequence, and comprises said VH gene segment or expresses antibodies comprising VH domains that are derived from the recombination of said human VH gene segment, a human D gene segment and a human JH gene segment.
In an embodiment, said mutation is I474V. In another embodiment, said mutation is E670G.

2. The antibody or antibody fragment of paragraph 1, wherein the human has been determined to comprise the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1 and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein encoded by the nucleotide sequence of SEQ ID NO: 29 or 30.

3. The antibody or antibody fragment of paragraphs 1 or 2, the method comprising the step of determining that the human comprises the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein comprising said mutation I474V or E670G, optionally, wherein the determining step is performed before administration of the antibody to the human.

4. The antibody or antibody fragment of paragraph 3, wherein the step of determining comprises assaying a biological sample from the human for a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain

comprising the mutation I474V or E670G in SEQ ID NO: 1.

5. The antibody or antibody fragment of paragraph 4, wherein the assaying comprises contacting the biological sample with

a. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides that can specifically hybridize to and identify in the biological sample a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or that specifically hybridizes to an antisense of said sequence, wherein said nucleic acid hybridizes to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridizes to an antisense sequence thereby forming a complex when at least one nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and/or

b. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides of a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or comprising an antisense sequence of said contiguous nucleotides, wherein said sequence of contiguous nucleotides comprises at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 thereby forming a complex when the nucleotide sequence encoding the PCSK9 that comprises a C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and

detecting the presence or absence of the complex, wherein detecting the presence of the complex determines that the human comprises the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

6. The antibody or antibody fragment of paragraph 4 or 5, wherein the assaying comprises nucleic acid amplification and optionally one or more methods selected from sequencing, next generation sequencing, nucleic acid hybridization, and allele-specific amplification and/or wherein the assaying is performed in a multiplex format.

7. The antibody or antibody fragment of any one of paragraphs 1 to 6, wherein said antibody or antibody fragment is for administration to a human that is or has been further determined to be substantially resistant to statin treatment.

8. The antibody or antibody fragment of any one of paragraphs 1 to 7, wherein antibody or antibody fragment is for administration to a human that is receiving or has received statin treatment or has reduced responsiveness to statin treatment.

9. The antibody or antibody fragment of paragraph 7 or 8, wherein said antibody or antibody fragment is for administration to the human separately or simultaneously with said statin treatment.

10. The antibody or antibody fragment of any one of paragraphs 4 to 8, wherein said biological sample comprises serum, blood, faeces, tissue, a cell, urine and/or saliva of said human.

11. The antibody or antibody fragment of any one of paragraphs 1 to 10, wherein said human is indicated as heterozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising a mutation I474V or E670G, optionally, wherein said human is further indicated as comprising the nucleotide sequence of SEQ ID NO: 28, or said human is indicated as homozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising a mutation I474Vor E670G in SEQ ID NO: 1.

12. The antibody or antibody fragment of any one of paragraphs 1 to 11, wherein said human has been diagnosed with at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

13. The antibody or antibody fragment of any one of paragraphs 1 to 12, wherein said antibody or antibody fragment treats or reduces the risk in said human of at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

14. The antibody or antibody fragment of any one of paragraphs 1 to 13, wherein the nucleotide sequence is SEQ

ID NO: 29 or 30.

15. The antibody or antibody fragment of any one of paragraphs 1 to 14, wherein said antibody or antibody fragment is for administration by intravenous or subcutaneous administration and/or is comprised in an injectable preparation.

[0641] Further exemplary methods are in the paragraphs 1-16 as follows.

1. A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 or E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human variable domain that is derived from the recombination of a human VH gene segment, a human D gene segment and a human JH gene segment, wherein the VH gene segment is as defined in any one of clauses 80 to 90 and wherein said human comprises (i) comprises said VH gene segment or expresses antibodies comprising VH domains that are derived from the recombination of said human VH gene segment, a human D gene segment and a human JH gene segment and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1.
In an embodiment, said mutation is I474V. In another embodiment, said mutation is E670G.

2. The method of paragraph 1, comprising, before said administering, selecting said human comprising said nucleotide sequence of (ii).

3. The method of paragraph 1 or 2, wherein the human has been determined to comprise the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1 and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein encoded by the nucleotide sequence of SEQ ID NO: 29 or 30.

4. The method of any one of paragraphs 1 to 3, comprising the step of determining that the human comprises the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein comprising said mutation I474V or E670G, optionally, wherein the determining step is performed before administration of the antibody to the human.

5. The method of paragraph 4, wherein the step of determining comprises assaying a biological sample from the human for a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

6. The method of paragraph 5, wherein the assaying comprises contacting the biological sample with

a. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides that can specifically hybridize to and identify in the biological sample a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or that specifically hybridizes to an antisense of said sequence, wherein said nucleic acid hybridizes to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridizes to an antisense sequence thereby forming a complex when at least one nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and/or

b. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides of a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or comprising an antisense sequence of said contiguous nucleotides, wherein said sequence of contiguous nucleotides comprises at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 thereby forming a complex when the nucleotide sequence encoding the PCSK9 that comprises a C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and

detecting the presence or absence of the complex, wherein detecting the presence of the complex determines that the human comprises the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

7. The method of paragraph 5 or 6, wherein the assaying comprises nucleic acid amplification and optionally one or more methods selected from sequencing, next generation sequencing, nucleic acid hybridization, and allele-specific amplification and/or wherein the assaying is performed in a multiplex format.

8. The method of any one of paragraphs 1 to 7, wherein said human is or has been further determined to be substantially resistant to statin treatment.

9. The method of any one of paragraphs 1 to 8, wherein said human is receiving or has received statin treatment or has reduced responsiveness to statin treatment.

10. The method of paragraph 8 or 9, wherein said antibody or antibody fragment is administered to the human separately or simultaneously with said statin treatment.

11. The method of any one of paragraphs 5 to 7, wherein said biological sample comprises serum, blood, faeces, tissue, a cell, urine and/or saliva of said human.

12. The method of any one of paragraphs 1 to 11, wherein said human is indicated as heterozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising said mutation I474V or E670G, optionally, wherein said human is further indicated as comprising the nucleotide sequence of SEQ ID NO: 28, or said human is indicated as homozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising said mutation I474Vor E670G in SEQ ID NO: 1.

13. The method of any one of paragraphs 1 to 12, wherein said human has been diagnosed with at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

14. The method of any one of paragraphs 1 to 13, wherein said antibody or antibody fragment treats or reduces the risk in said human of at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

15. The method of any one of paragraphs 1 to 14, wherein the nucleotide sequence is SEQ ID NO: 29 or 30.

16. The method of any one of paragraphs 1 to 15, wherein said antibody or antibody fragment is administered by intravenous or subcutaneous administration and/or is comprised in an injectable preparation.

Regimens

[0642]

A: The invention further provides the following regimens, ligands and kits.

1. A method for treating a human PCSK9-mediated disease or condition in a human by targeting a rare variant human PCSK9, the method comprising administering to the human a ligand (eg, an antibody or fragment) that has been determined to specifically bind to said PCSK9variant; wherein the human expresses said PCSK9 variant or the genome of the human comprises a nucleotide sequence encoding said PCSK9 variant; wherein said human is treated for said disease or condition.

[0643] The variant PCSK9 can, for example, be any rare variant as described herein.

[0644] For example, there is provided:

1a. A method for treating a PCSK9-mediated disease or condition in a human by targeting a PCSK9 that comprises a C-terminal domain amino acid polymorphism (compared to SEQ ID NO: 1), the method comprising administering to the human a ligand (eg, an antibody or fragment) that has been determined to specifically bind to a PCSK9 comprising a C-terminal domain comprising I474V or 670G (numbering according to SEQ ID NO:1); wherein the human expresses said PCSK9 or the genome of the human comprises a nucleotide sequence encoding said PCSK9; wherein said human is treated for said disease or condition.

[0645] In an embodiment, determination of said specific binding is by reference to binding assay data, eg, as determined

using SPR or ELISA. Determination may, for example, be by reference to information in a printed publication, eg, with knowledge of data presented in the present or another patent application or in a journal article. Once armed with such knowledge (eg, in the absence of further testing of binding), the skilled person is able - by direction of the present invention - to treat a relevant human whose genotype or phenotype matches the binding specificity of the ligand.

[0646] The antibody or fragment can be according to any configuration, example, embodiment, aspect, clause or paragraph herein.

[0647] In an embodiment, the method comprises, before said administering, selecting a human comprising said nucleotide sequence encoding the PCSK9, wherein the human is said human in clause 1 (eg, 1a).

2. The method of clause 1, comprising before said administering the step of determining that the ligand specifically binds to said PCSK9, eg, using SPR or ELISA.

3. The method of clause 1 or 2, wherein the specific binding to said PCSK9 is binding with a dissociation constant (Kd) of 1nM or less, eg, 100, 10 or 1pM or less.

4. The method of any of clauses 1 to 3 (eg, clause 1a), wherein the condition is elevated LDL-cholesterol or is caused by elevated LDL-cholesterol.

5. The method of clause 4 (eg, when dependent from clause 1a), wherein the condition is selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

6. The method of any one of clauses 1 to 5 (eg, when dependent from clause 1a), wherein the human has been determined to comprise the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1 and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein encoded by the nucleotide sequence of SEQ ID NO: 29 or 30.

7. The method of any one of clauses 1 to 6 (eg, when dependent from clause 1a), comprising the step of determining that the human comprises the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein comprising said mutation I474V or E670G, optionally, wherein the determining step is performed before administration of the antibody to the human.

8. The method of clause 7, wherein the step of determining comprises assaying a biological sample from the human for a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

9. The method of clause 8, wherein the assaying comprises contacting the biological sample with

a. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides that can specifically hybridize to and identify in the biological sample a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or that specifically hybridizes to an antisense of said sequence, wherein said nucleic acid hybridizes to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridizes to an antisense sequence thereby forming a complex when at least one nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and/or

b. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides of a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or comprising an antisense sequence of said contiguous nucleotides, wherein said sequence of contiguous nucleotides comprises at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 thereby forming a complex when the nucleotide sequence encoding the PCSK9 that comprises a C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and

detecting the presence or absence of the complex, wherein detecting the presence of the complex determines that the human comprises the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

10. The method of clause 8 or 9, wherein the assaying comprises nucleic acid amplification and optionally one or more methods selected from sequencing, next generation sequencing, nucleic acid hybridization, and allele-specific amplification and/or wherein the assaying is performed in a multiplex format.

11. The method of any one of clauses 1 to 10, wherein said human is or has been further determined to be substantially resistant to statin treatment.

12. The method of any one of clauses 1 to 11, wherein said human is receiving or has received statin treatment or has reduced responsiveness to statin treatment.

13. The method of clauses 11 or 12, wherein said antibody or antibody fragment is administered to the human separately or simultaneously with said statin treatment.

14. The method of any one of clauses 8 to 10, wherein said biological sample comprises serum, blood, faeces, tissue, a cell, urine and/or saliva of said human.

15. The method of any one of clauses 1 to 14, wherein said human is indicated as heterozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising said mutation I474V or E670G, optionally, wherein said human is further indicated as comprising the nucleotide sequence of SEQ ID NO: 28, or said human is indicated as homozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising said mutation I474Vor E670G in SEQ ID NO: 1.

16. The method of any one of clauses 1 to 15, wherein said human has been diagnosed with at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

17. The method of any one of clauses 1 to 16, wherein said antibody or antibody fragment treats or reduces the risk in said human of at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

18. The method of any one of clauses 1 to 17, wherein the nucleotide sequence is SEQ ID NO: 29 or 30.

19. The method of any one of clauses 1 to 18, wherein said antibody or antibody fragment is administered by intravenous or subcutaneous administration and/or is comprised in an injectable preparation.

20. A ligand (eg, an antibody or fragment) for use in the method of any one of clauses 1 to 19, wherein the ligand specifically binds the PCSK9.

21. A kit comprising the ligand of clause 20 and instructions for carrying out the method of any one of clauses 1 to 19.

[0648] B: The invention further provides the following regimens, ligands and kits.

1. A method of reducing cholesterol level or maintaining a previously reduced cholesterol level in a human in need thereof, the method comprising

a. Carrying out an initial treatment of said human for an initial treatment period by administering an anti-human PCSK9 ligand (eg, an antibody or fragment) to said human, wherein (i) the ligand has been determined to specifically bind to a PCSK9 comprising a C-terminal domain comprising I474V or 670G (numbering according to SEQ ID NO:1); (ii) the human expresses said PCSK9 or the genome of the human comprises a nucleotide sequence encoding said PCSK9 and (iii) the human has received or is receiving statin treatment to lower or maintain cholesterol level; wherein the initial treatment comprises the administration of a single or multiple doses of the ligand to the human;
b. Determining to (i) terminate statin treatment (ii) keep the human off statin treatment; or (iii) reduce statin treatment after said initial treatment period; and
c. Continuing to administer the ligand to said patient after said time period has expired, thereby reducing cholesterol level or maintaining a previously reduced cholesterol level in said human.

[0649] In an embodiment, determination of said specific binding is by reference to binding assay data, eg, as determined using SPR or ELISA. Determination may, for example, be by reference to information in a printed publication, eg, with knowledge of data presented in the present or another patent application or in a journal article. Once armed with such knowledge (eg, in the absence of further testing of binding), the skilled person is able - by direction of the present invention - to treat a relevant human whose genotype or phenotype matches the binding specificity of the ligand.

[0650] The antibody or fragment can be according to any configuration, example, embodiment, aspect, clause or paragraph herein.

[0651] A pharmaceutically-effective amount of said ligand is administered.

[0652] In an embodiment, the method comprises, before said administering, selecting a human comprising said nucleotide sequence encoding the PCSK9, wherein the human is said human recited in clause 1.

[0653] In an example, the initial treatment period is 7 days, 14 days, 21 days, 28 days, a month, two months, three months, four months, five months, six months, seven months, eight months, nine months or a year.

2. The method of clause 1, wherein the human has or is suffering from statin-associated memory loss or a statin-associated neurodegenerative condition, or has or is at increased risk of diabetes (eg, statin-associated diabetes).

3. The method of clause 1 or 2, comprising, before said initial treatment, the step of determining that the human has or is suffering from statin-associated memory loss or a statin-associated neurodegenerative condition, or has or is at increased risk of diabetes (eg, statin-associated diabetes).

4. The method of clause 2 or 3, comprising, after step (b) (eg, during step (c)) determining that the memory loss or said neurodegenerative condition has improved.

5. The method of any one of clauses 1 to 4, wherein said human is over 40 years of age (eg, 50 or over, 55 or over, 60 or over, 65 or over, or 70 or over).

6. The method of any one of clauses 1 to 5, wherein step (c) comprises determining to increase the doses of said ligand to be administered after said initial treatment period and administering said increased doses to said human.

7. The method of any one of clauses 1 to 6, wherein step (b) comprises determining that the human is intolerant or refactory to treatment by a statin.

8. The method of any one of clauses 1 to 7, wherein the initial treatment comprises the administration of a statin, fenofibrate (eg, Tricor™ or Lofibra™) or ezetimibe to the human in addition to the ligand.

9. The method of any one of clauses 1 to 8, wherein step (b) comprises terminating or reducing statin, fenofibrate (eg, Tricor™ or Lofibra™) or ezetimibe treatment during step (c).

10. The method of any one of clauses 1 to 9, comprising increasing (ie, increasing compared to the initial treatment dose) the ligand dose during step (c).

11. The method of any one of clauses 1 to 10, wherein the human has received high dose statin treatment prior to the initial treatment, and wherein step (c) comprises administering a lower (eg, a medium or low) dose statin treatment in addition to said ligand.

[0654] The skilled person is familiar with the meaning of high, medium and low dose treatments (and how to determine according to each patient, eg, the patient's body mass). For example, the statin is selected from rosuvastatin, atorvastatin and simvastatin.

[0655] For example daily statin doses are as follows:- Low 10 to 20mg (eg, 10mg); medium >20 and <60mg (eg, 40mg); high 60-100mg (eg, 80mg).

12. The method of any one of clauses 1 to 10, wherein the human has received medium dose statin treatment prior to the initial treatment, and wherein step (c) comprises administering a lower (eg, a low) dose statin treatment or no statin in addition to said ligand.

13. The method of any one of clauses 1 to 10, wherein the human has received low dose statin treatment prior to the initial treatment, and wherein step (c) comprises administering no statin in addition to said ligand.

14. The method of any one of clauses 1 to 13, comprising, before the initial treatment, the step of determining that the ligand specifically binds to said PCSK9, eg, using SPR or ELISA.

15. The method of any one of clauses 1 to 14, wherein the specific binding to said PCSK9 is binding with a dissociation constant (Kd) of 1nM or less, eg, 100, 10 or 1pM or less.

16. The method of any of clauses 1 to 15, wherein the human is at risk of or suffering from a condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

17. The method of clause 16, wherein step (c) treats or reduces the risk of said condition in the human.

18. The method of any one of clauses 1 to 17, wherein the human has been determined to comprise the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1 and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein encoded by the nucleotide sequence of SEQ ID NO: 29 or 30.

19. The method of any one of clauses 1 to 18, comprising the step of determining that the human comprises the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein comprising said mutation I474V or E670G, optionally, wherein the determining step is performed before administration of the antibody to the human.

20. The method of clause 19, wherein the step of determining comprises assaying a biological sample from the human for a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

21. The method of clause 20, wherein the assaying comprises contacting the biological sample with

a. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides that can specifically hybridize to and identify in the biological sample a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or that specifically hybridizes to an antisense of said sequence, wherein said nucleic acid hybridizes to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridizes to an antisense sequence thereby forming a complex when at least one nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and/or

b. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides of a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or comprising an antisense sequence of said contiguous nucleotides, wherein said sequence of contiguous nucleotides comprises at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 thereby forming a complex when the nucleotide sequence encoding the PCSK9 that comprises a C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and

detecting the presence or absence of the complex, wherein detecting the presence of the complex determines that the human comprises the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

22. The method of clause 20 or 21, wherein the assaying comprises nucleic acid amplification and optionally one or more methods selected from sequencing, next generation sequencing, nucleic acid hybridization, and allele-specific amplification and/or wherein the assaying is performed in a multiplex format.

23. The method of any one of clauses 1 to 22, wherein said human is or has been further determined to be substantially resistant to statin treatment.

24. The method of any one of clauses 20 to 22, wherein said biological sample comprises serum, blood, faeces, tissue, a cell, urine and/or saliva of said human.

25. The method of any one of clauses 1 to 24, wherein said human is indicated as heterozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising said mutation I474V or E670G, optionally, wherein said human is further indicated as comprising the nucleotide sequence of SEQ ID NO: 28, or said human is indicated as homozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising said mutation I474Vor E670G in SEQ ID NO: 1.

26. The method of any one of clauses 1 to 25, wherein said human has been diagnosed with at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication and high blood pressure.

27. The method of any one of clauses 1 to 26, wherein the nucleotide sequence is SEQ ID NO: 29 or 30.

28. The method of any one of clauses 1 to 27, wherein said ligand (eg, antibody or antibody fragment) is administered by intravenous or subcutaneous administration and/or is comprised in an injectable preparation.

29. A ligand (eg, an antibody or fragment) for use in the method of any one of clauses 1 to 28, wherein the ligand specifically binds the PCSK9.

30. A kit comprising the ligand of clause 29 and instructions for carrying out the method of any one of clauses 1 to 28.

[0656] In an example of any aspect of the invention, the ligand (eg, antibody or fragment, eg, alirocumab, bocovizumab or evolocumab, or an antibody or fragment comprising the variable domains of 316P or 31H4) is administered to the human at a two-weekly dose of from 75 to 150mg (eg, from 75 to 150mg administered once or twice over a two-week period). In an example, the ligand is for such administration to the human.

EXAMPLES

Example 1: Rare PCSK9 Variants

[0657] The present invention provides anti-PCSK9 ligands; and PCSK9-binding or targeting ligands as described herein. The ligands have a variety of utilities. Some of the ligands, for instance, are useful in specific binding assays, for genotyping or phenotyping humans, affinity purification of PCSK9, in particular human PCSK9 or its ligands and in screening assays to identify other antagonists of PCSK9 activity. Some of the ligands of the invention are useful for inhibiting binding of PCSK9 to LDLR, or inhibiting PCSK9-mediated activities.

[0658] Anti-PCSK9 ligands (eg, antibodies and anti-sense RNA) have been developed based on targeting and neutralising so-called "wild-type" human PCSK9, which is a commonly-occurring form (see, eg, US20120093818A1 and US20110065902A1). While such therapies are useful for human patients harbouring this form of human PCSK9, the inventor considered it useful to investigate the possibility of targeting much rarer - but still naturally-occurring - forms of PCSK9 amongst human populations. In this way, the inventor arrived at insight into the natural occurrences and distributions of rarer human PCSK9 forms that can serve as useful targets (at the protein or nucleic acid level) for human treatment, prophylaxis and diagnosis pertinent to diseases and conditions mediated or associated with PCSK9 activity. This particularly provides for tailored therapies, prophylaxis and diagnosis in humans that are devoid of the common PCSK9 gene or protein (ie, the form *a* or *a'* as used in US20120093818A1 and US20110065902A1 to generate antibodies).

[0659] The skilled person will know that SNPs or other changes that translate into amino acid variation can cause variability in activity and/or conformation of human targets to be addressed. This has spawned great interest in personalized medicine where genotyping and knowledge of protein and nucleotide variability is used to more effectively tailor medicines and diagnosis of patients. The invention, therefore, provides for tailored pharmaceuticals and testing that specifically addresses rarer PCSK9 polymorphic variant forms. Such forms or "alleles" (at the nucleotide level), in many of the examples determined by the inventor, comprise multiple changes at the nucleotide and amino acid levels from the corresponding common form nucleotide and amino acids sequences, ie, there are multiple non-synonymous changes at the nucleotide level that translate into multiple corresponding changes in the protein target in humans.

[0660] Furthermore, the inventor surprisingly realised that the rarer natural forms, although present in humans at much lower frequencies than the common form, nevertheless are represented in multiple and ethnically-diverse human populations and usually with many human examples per represented ethnic population. Thus, the inventor realised that targeting such rarer forms would provide for effective treatment, prophylaxis or diagnosis across many human ethnic populations, thereby extending the utility of the present invention.

[0661] With this realisation, the inventor realised that there is significant industrial and medical application for the

invention in terms of guiding the choice of anti-PCSK9 ligand for administration to human patients for therapy and/or prophylaxis of PCSK9-mediated or associated diseases or conditions. In this way, the patient receives drugs and ligands that are tailored to their needs - as determined by the patient's genetic or phenotypic makeup. Hand-in-hand with this, the invention provides for the genotyping and/or phenotyping of patients in connection with such treatment, thereby allowing a proper match of drug to patient. This increases the chances of medical efficacy, reduces the likelihood of inferior treatment using drugs or ligands that are not matched to the patient (eg, poor efficacy and/or side-effects) and avoids pharmaceutical mis-prescription and waste.

[0662] In developing this thinking, in this non-limiting example the present inventor decided to determine a set of human PCSK9 variants on the basis of the following criteria, these being criteria that the inventor realised would provide for useful medical drugs and diagnostics to tailored need in the human population. The inventor selected variants having at least 3 of the 4 following criteria:-

- PCSK9 variants having a cumulative human allele frequency in the range from 1 to 10%;
- PCSK9 variants having a total human genotype frequency in the range from 1 to about 15%;
- PCSK9 variants found in many different human ethnic populations (using the standard categorisation of the 1000 Genomes Project, which is an accepted standard in the art; see Table 4 below); and
- PCSK9 variants found in many individuals distributed across such many different ethnic populations.

[0663] On the basis of these criteria, the inventor identified the variants listed in Table 1 below (excluding form *a*).

[0664] The inventor's selection included, as a consideration, selection for nucleotide variation that produced amino acid variation in corresponding PCSK9 forms (ie, non-synonymous variations), as opposed to silent variations that do not alter amino acid residues in the target protein.

Table 1: Human PCSK9 variants distributed over several human ethnic populations & having a total human genotype frequency in the range of 1 to about 15%

(a) Amino acid variability, population distributions and frequencies

Form *a*	46R	53A	425N	443A	474I	619Q	670E	ASW,YRI, GBR, TSI, CLM,CHB, LWK,CHS, MXL, JPT, PUR,IBS,FIN, CEU	939	14	0.3951	0.4506 (0.8457)	0.64815
Variant Form	**Amino Acid Position & Variation**							**Human Populations**	**No. Individis[1]**	**No. Unique Pops[2]**	**Het Freq[3]**	**Hom Freq[4] (Het+Hom freq5)**	**Cum Freq[6]**
	46L	53V	425S	443T	474V	619P	670G						
f					x			ASW,YRI, GBR, TSI, CLM,LWK, MXL,JPT, PUR,IBS, FIN,CEU			180 12 0.153 0.009 (0.162) 0.0855		
c							x	ASW,YRI, GBR,TSI, CLM,CHB, LWK,CHS, JPT,PUR, FIN,CEU			153 12 0.1296 0.0081 (0.01377) 0.0729		
r					x		x				0.0234	0.009 (0.0324)	0.0292
p		x			x			ASW,GBR, TSI, CLM, JPT,PUR, IBS,FIN, CEU			49 9 0.0441	(0.0441)	0.0221
m				x				LWK,ASW, YRI,CLM	29	4	0.0225	(0.0225)	0.0149
e			x		x			LWK,ASW, YRI	15	3	0.0135	(0.0135)	0.0068

(continued)

(a) Amino acid variability, population distributions and frequencies													
Form *a*	46R	53A	425N	443A	474I	619Q	670E	ASW,YRI, GBR, TSI, CLM,CHB, LWK,CHS, MXL, JPT, PUR,IBS,FIN, CEU	939	14	0.3951	0.4506 (0.8457)	0.64815
Variant Form	**Amino Acid Position & Variation**							**Human Populations**	**No. Individis[1]**	**No. Unique Pops[2]**	**Het Freq[3]**	**Hom Freq[4] (Het + Hom freq5)**	**Cum Freq[6]**
	46L	53V	425S	443T	474V	619P	670G						
h				x		x		LWK,ASW, YRI	10	3	0.009	(0.009)	0.0045
aj	X				x			PUR,TSI, FIN,CE U	9	4	0.0081	(0.0081)	0.0041
q		x					x	CHS,ASW, JPT, PUR, CHB	7	5	0.0063	(0.0063)	0.0032

Table Footnotes:

"x" in a box indicates that the amino acid for the variant form is different from the amino acid at that position in form *a,* the variant amino acid being shown in " **Amino Acid Position & Variation"** of the table and the form *a* amino acid being shown in the first row of the table; amino acids at all other positions of each variant form are identical to those found in form *a.*

Amino acid numbering is per the numbering shown for the pro-form in Table 2 below.

1. Number of individuals in 1000 Genomes database found to have the allele;
2. Number of unique human ethnic populations in 1000 Genomes database in which the allele was found to occur;
3. Heterozygous human genotype frequency, ie, cumulative frequency of all genotypes having one occurrence of the variant allele and one occurrence of another allele (heterozygous state), eg, *ac* genotype in 1000 Genomes database;
4. Homozygous human genotype frequency, ie, cumulative frequency of two occurrences of the variant allele (homozygous state), eg, *cc* genotype in 1000 Genomes database; and
5. Total human genotype frequency, ie, total of heterozygous plus homozygous human genotype frequencies.
6. Cumulative human allele frequency of all occurrences of the variant allele in 1000 Genomes database.

Form *a'*is identical to form *a* with the exception that form *a'*has a glycine (G) at position 620 (see US20120093818 (Amgen, Inc)); form *a* has E at this position .

(continued)

(b) Nucleotide Sequence Variations of Selected Alleles							
Allele *a*	G	C	A	G	A	A	A
Variant Allele	**Nucleotide Position[1]**						
	1:55505647	1:55505668	1:55523802	1:55523855	1:55524237	1:55527222	1: 55529187
	Non-Synonymous Nucleotide Variaton[2]						
	T	T	G	A	G	C	G
	Variant ID[3]						
	rs11591147	rs11583680	rs28362261	rs28362263	rs562556	rs28362277	rs505151
	Corresponding Amino Acid Variation						
	46L	53V	425S	443T	474V	619P	670G
f					X		
c							X
r					X		X
p		X			X		
m				X			
e			X		X		
h				X		X	
aj	X				X		
q		X					X
"x" in a box indicates that a variant allele comprises the non-synonymous nucleotide variation indicated in the 5th row.							

[0665] Table Footnotes:

1. Notation is chromosome number (all positions are on human chromosome 1):coordinate number (Ensembl release 73 - September 2013, Genome assembly: GRCh37 (GCA_000001405.13);
2. Nucleotide change (compared to allele a nucleotide shown in first row) giving rise to an amino acid change in the variant form (compared to amino acid of allele *a*); and
3. NCBI dbSNP reference number (NCBI dbSNP Build 138 released on Apr 25, 2013).

Table 2: Sequences

(a) Human PCSK9 Form a Amino Acid Sequence (SEQ ID NO:1) - "Pro-form" with Signal Sequence

46 53

*MGTVSSRRSWWPLPLLLLLLLLGPAGARA*QEDEDGDYEELVLALRSEEDGLAEAPEHGTTATFHRCAKDE

WRLPGTYVVVLKEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH

VDYIEEDSSVFAQsipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg

thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly

spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsal

425 443 474

dvineawfpedqrvltpnlvaalppsthGAGWQLFCRTVWSAHSGPTRMATALARCAPDEELLSCSSFSRSGKRRGERM

EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT

619 620

HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAV

670

AVDNTCVVRSRDVSTTGSTSEEAVTAVAICCRSRHLAQASQELQ

Italics = signal sequence 1-30
Courier = pro peptide 31-152
lower case = catalytic domain 153-449
UPPER CASE = C-terminal domain 450-692
Underlined = residues changed from allele a in other sequences (aa residue number shown)
The pro-form is the sequence from amino acid number 31 to (and including) amino acid number 692 of SEQ ID NO: 1.
The mature form is the sequence from amino acid number 153 to (and including) amino acid number 692 of SEQ ID NO: 1.

(b) Human PCSK9 Form a Amino Acid Sequence (SEQ ID NO:3) - "Mature-form"

(Numbering and notation as per SEQ ID NO: 1 above has been retained)

(continued)

(b) Human PCSK9 Form a Amino Acid Sequence (SEQ ID NO:3) - "Mature-form"

sipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg

thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacl

spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsal

425 443 474

dvineawfpedqrvltpnlvaalppsthGAGWQLFCRTVWSAHSGPTRMATAIARCAPDEELLSCSSFSRSGKRRGERM

EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLG

619 620

HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGA

670

AVDNTCVVRSRDVSTTGSTSEEAVTAVAICCRSRHLAQASQELQ

(c) **Human PCSK9 Allele a Nucleotide Sequence (SEQ ID NO: 28) - Encoding "Pro-form" Plus Signal Sequence**

ATGGGCACCGTCAGCTCCAGGCGGTCCTGGTGGCCGCTGCCACTGCTGCTGCTGCTGCTGCTCCTGGGTC

R46L CGT to CTT

*CCGCGGGCGCCCGTGCG*CAGGAGGACGAGGACGGCGACTACGAGGAGCTGGTGCTAGCCTTGCGTTCCC

A53V GCC to GTC

AGGAGGACGGCCTGGCCGAAGCACCCGAGCACGGAACCACAGCCACCTTCCACCGCTGCGCCAAGGAT

CCGTGGAGGTTGCCTGGCACCTACGTGGTGGTGCTGAAGGAGGAGACCCACCTCTCGCAGTCAGAGCG

CACTGCCCGCCGCCTGCAGGCCCAGGCTGCCCGCCGGGGATACCTCACCAAGATCCTGCATGTCTTCC

ATGGCCTTCTTCCTGGCTTCCTGGTGAAGATGAGTGGCGACCTGCTGGAGCTGGCCTTGAAGTTGCCC

CATGTCGACTACATCGAGGAGGACTCCTCTGTCTTTGCCCAGagcatcccgtggaacctggagcggattacccctcc

cggtaccgggcggatgaataccagcccccgacggaggcagcctggtggaggtgtatctcctagacaccagcatacagagtgaccaccggga

atcgagggcagggtcatggtcaccgacttcgagaatgtgcccgaggaggacgggacccgcttccacagacaggccagcaagtgtgacagtca

ggcacccacctggcaggggtggtcagcggcccgggatgccggcgtggccaagggtgccagcatgcgcagcctgcgcgtgctcaactgccaagg

aagggcacggttagcggcaccctcataggcctggagtttattcggaaaagccagctggtccagcctgtggggccactggtggtgctgctgcccc

ggcgggtgggtacagccgcgtcctcaacgccgcctgccagcgcctggcgagggctggggtcgtgctggtcaccgctgccggcaacttccggga

gatgcctgcctctactccccagcctcagctcccgaggtcatcacagttggggccaccaatgcccaagaccagccggtgaccctggggactttgg

gaccaactttggccgctgtgtggacctctttgccccaggggaggacatcattggtgcctccagcgactgcagcacctgctttgtgtcacagagtg

gacatcacaggctgctgcccacgtggctggcattgcagccatgatgctgtctgccgagccggagctcaccctggccgagttgaggcagagactg

(continued)

(c) **Human PCSK9 Allele a Nucleotide Sequence (SEQ ID NO: 28) - Encoding "Pro-form" Plus Signal Sequence**

N425S AAT to AGT A443T GCC to ACC

atccacttctctgccaaagatgtcatcaatgaggcctggttccctgaggaccagcgggtactgacccccaacctggtggccgccctgccccccaf

cacccatGGGGCAGGTTGGCAGCTGTTTTGCAGGACTGTATGGTCAGCACACTCGGGGCCTACACGGATGGCC

I474V ATC to GTC

ACAGCCATCGCCCGCTGCGCCCCAGATGAGGAGCTGCTGAGCTGCTCCAGTTTCTCCAGGAGTGGGAAGCGG

CGGGGCGAGCGCATGGAGGCCCAAGGGGGCAAGCTGGTCTGCCGGGCCCACAACGCTTTTGGGGGTGAGG

GTGTCTACGCCATTGCCAGGTGCTGCCTGCTACCCCAGGCCAACTGCAGCGTCCACACAGCTCCACCAGCTGA

GGCCAGCATGGGGACCCGTGTCCACTGCCACCAACAGGGCCACGTCCTCACAGGCTGCAGCTCCCACTGGGA

GGTGGAGGACCTTGGCACCCACAAGCCGCCTGTGCTGAGGCCACGAGGTCAGCCCAACCAGTGCGTGGGCC

ACAGGGAGGCCAGCATCCACGCTTCCTGCTGCCATGCCCCAGGTCTGGAATGCAAAGTCAAGGAGCATGGAA

Q619P CAG to CCG E620G GAG to GGG

TCCCGGCCCCTCAGGAGCAGGTGACCGTGGCCTGCGAGGAGGGCTGGACCCTGACTGGCTGCAGTGCCCTC(

CTGGGACCTCCCACGTCCTGGGGGCCTACGCCGTAGACAACACGTGTGTAGTCAGGAGCCGGGACGTCAGCA

E670G GAG to GGG

CTACAGGCAGCACCAGCGAAGAGGCCGTGACAGCCGTTGCCATCTGCTGCCGGAGCCGGCACCTGGCGCAG

GCCTCCCAGGAGCTCCAGTGAC

Italics = nucleotide sequence encoding signal sequence (nucleotides 1-90)
Courier = nucleotide sequence encoding pro peptide (nucleotides 91-456)
lower case = nucleotide sequence encoding catalytic domain (nucleotides 457-1346)
UPPER CASE = nucleotide sequence encoding C-terminal domain (nucleotides 1347-2076)
Underlined = allelic variations from allele a in other sequences (aa residue number changes and codon changes shown)
The pro-form is encoded by nucleotide sequence from nucleotide 91 to (and including) nucleotide 2076.
The mature form is encoded by nucleotide sequence from nucleotide 457 to (and including) nucleotide 2076.

Variant Allele Nucleotide Sequences

[0666] Thus,

(i) The nucleotide sequence of allele *f* is identical to SEQ ID NO: 28 except that the nucleotide sequence of allele *f* comprises a GTC codon instead of an ATC codon at the position labelled "I474V" in SEQ ID NO: 28;
(ii) The nucleotide sequence of allele *c* is identical to SEQ ID NO: 28 except that the nucleotide sequence of allele *c* comprises a GGG codon instead of an GAG codon at the position labelled "E670G" in SEQ ID NO: 28;
(iii) The nucleotide sequence of allele *r* is identical to SEQ ID NO: 28 except that the nucleotide sequence of allele *r* comprises a GTC codon instead of an ATC codon at the position labelled "I474V" in SEQ ID NO: 28; and a GGG codon instead of an GAG codon at the position labelled "E670G" in SEQ ID NO: 28;
(iv) The nucleotide sequence of allele *p* is identical to SEQ ID NO: 28 except that the nucleotide sequence of allele *p* comprises a GTC codon instead of a GCC codon at the position labelled "A53V" in SEQ ID NO: 28; and a GTC codon instead of an ATC codon at the position labelled "I474V" in SEQ ID NO: 28;
(v) The nucleotide sequence of allele *m* is identical to SEQ ID NO: 28 except that the nucleotide sequence of allele *m* comprises a ACC codon instead of a GCC codon at the position labelled "A443T" in SEQ ID NO: 28;
(vi) The nucleotide sequence of allele *e* is identical to SEQ ID NO: 28 except that the nucleotide sequence of allele *e* comprises a AGT codon instead of an AAT codon at the position labelled "N425S" in SEQ ID NO: 28; and a GTC codon instead of an ATC codon at the position labelled "I474V" in SEQ ID NO: 28;
(vii) The nucleotide sequence of allele *h* is identical to SEQ ID NO: 28 except that the nucleotide sequence of allele *h* comprises a ACC codon instead of a GCC codon at the position labelled "A443T" in SEQ ID NO: 28; and a CCG codon instead of a CAG codon at the position labelled "Q619P" in SEQ ID NO: 28;

(viii) The nucleotide sequence of allele *aj* is identical to SEQ ID NO: 28 except that the nucleotide sequence of allele *aj* comprises a CTT codon instead of an CGT codon at the position labelled "R46L" in SEQ ID NO: 28; and a GTC codon instead of an ATC codon at the position labelled "I474V" in SEQ ID NO: 28; and
(ix) The nucleotide sequence of allele *q* is identical to SEQ ID NO: 28 except that the nucleotide sequence of allele *q* comprises a GTC codon instead of a GCC codon at the position labelled "A53V" in SEQ ID NO: 28; and a GGG codon instead of an GAG codon at the position labelled "E670G" in SEQ ID NO: 28.

[0667] Variant Pro-Form Amino Acid Sequences (Numbering is as per SEQ ID NO: 1 recited above)

(A) The amino acid sequence of form *f* is identical to the amino acid sequence from amino acid number 31 to (and including) amino acid number 692 of SEQ ID NO: 1 except that the amino acid sequence of form *f* comprises a valine at position 474;
(B) The amino acid sequence of form *c* is identical to the amino acid sequence from amino acid number 31 to (and including) amino acid number 692 of SEQ ID NO: 1 except that the amino acid sequence of form *c* comprises a glycine at position 670;
(C) The amino acid sequence of form *r* is identical to the amino acid sequence from amino acid number 31 to (and including) amino acid number 692 of SEQ ID NO: 1 except that the amino acid sequence of form *r*comprises a valine at position 474 and a glycine at position 670;
(D) The amino acid sequence of form *p* is identical the amino acid sequence from amino acid number 31 to (and including) amino acid number 692 of SEQ ID NO: 1 except that the amino acid sequence of form *p* comprises a valine at position 53 and a valine at position 474;
(E) The amino acid sequence of form *m* is identical to the amino acid sequence from amino acid number 31 to (and including) amino acid number 692 of SEQ ID NO: 1 except that the amino acid sequence of form *m* comprises a threonine at position 443;
(F) The amino acid sequence of form *e* is identical to the amino acid sequence from amino acid number 31 to (and including) amino acid number 692 of SEQ ID NO: 1 except that the amino acid sequence of form *e* comprises a serine at position 425 and a valine at position 474;
(G) The amino acid sequence of form *h* is identical to the amino acid sequence from amino acid number 31 to (and including) amino acid number 692 of SEQ ID NO: 1 except that the amino acid sequence of form *h* comprises a threonine at position 443 and a proline at position 619;
(H) The amino acid sequence of form *aj* is identical to the amino acid sequence from amino acid number 31 to (and including) amino acid number 692 of SEQ ID NO: 1 except that the amino acid sequence of form *aj* comprises a leucine at position 46 and a valine at position 474; and
(I) The amino acid sequence of form *q* is identical to the amino acid sequence from amino acid number 31 to (and including) amino acid number 692 of SEQ ID NO: 1 except that the amino acid sequence of form *q* comprises a valine at position 53 and a glycine at position 670.

[0668] Variant Mature Form Amino Acid Sequences (Numbering is as per SEQ ID NO: 1 recited above)

(A') The amino acid sequence of form *f* is identical to SEQ ID NO: 2 except that the amino acid sequence of form *f* comprises a valine at position 474;
(B') The amino acid sequence of form *c* is identical to SEQ ID NO: 2 except that the amino acid sequence of form *c* comprises a glycine at position 670;
(C') The amino acid sequence of form *r* is identical to SEQ ID NO: 2 except that the amino acid sequence of form *r* comprises a valine at position 474 and a glycine at position 670;
(D') The amino acid sequence of form *p* is identical to SEQ ID NO: 2 except that the amino acid sequence of form *p* comprises a valine at position 474;
(E') The amino acid sequence of form *m* is identical to SEQ ID NO: 2 except that the amino acid sequence of form *m* comprises a threonine at position 443;
(F') The amino acid sequence of form *e* is identical to SEQ ID NO: 2 except that the amino acid sequence of form *e* comprises a serine at position 425 and a valine at position 474;
(G') The amino acid sequence of form *h* is identical to SEQ ID NO: 2 except that the amino acid sequence of form *h* comprises a threonine at position 443 and a proline at position 619;
(H') The amino acid sequence of form *aj* is identical to SEQ ID NO: 2 except that the amino acid sequence of form *aj* comprises valine at position 474; and
(I') The amino acid sequence of form *q* is identical to SEQ ID NO: 2 except that the amino acid sequence of form *q* comprises a glycine at position 670.

[0669] The mature form of *p* is identical to the mature form of fand *aj.*

[0670] The mature form of *c* is identical to the mature form of *q.*

[0671] Further sequence analysis and 3D *in silico* modelling (see Figure 1) revealed that selected variants also fulfilled the following additional selection criteria:-

- PCSK9 variants whose variant amino acid residues (versus the common form of human PCSK9) are found in the mature form of the target (ie, outside the pro-domain); and
- PCSK9 variants whose variant amino acid residues (versus the common form of human PCSK9) are surface-exposed on the target, which the inventor saw as contributing to determining the topography of the target and potentially contributing to how and where ligand binding on the target occurs.

[0672] As shown in Figure 1, identified positions 425, 443, 474, 619 and 670 (found in the selected variants of the invention) are all surface-exposed and outside of the pro-domain. Variant positions 425 and 443 are surface-exposed on the catalytic domain, while variant positions 474, 619 and 670 are surface-exposed on the C-terminal domain.

[0673] The inventor, thus, applied the novel selection criteria to determine rare variant forms of human PCSK9, realising the utility of their nucleotide and amino acid sequences in the various configurations, aspects, clauses, embodiments and example of the invention herein, and thereby providing for novel personalized medical and diagnostic applications as described above.

Tailoring Antibodies to Rare PCSK9 Variant Profile

[0674] As outlined above, the invention includes the possibility to tailor treatment of humans further by selecting antibody-based ligands with variable domains based on gene segments commonly found in humans of the ethnic populations where the variant PCSK9 forms are found to meet the selection criteria of the invention. An example is provided below for ligands comprising antibody VH domains derived from recombination of human VH3-23.

[0675] The inventor analysed the frequencies and distribution of various human VH3-23 alleles and realised the desirability of using ligands based on human VH3-23 alleles comprising SNP rs56069819. This SNP corresponds to a change from leucine at position 24 in the encoded protein sequence to a valine at that position (L24V change) and the SNP is at coordinate 106268889 on human chromosome 14.

[0676] Figure 2 shows the cumulative allele frequency distribution across the 1000 Genomes Project database of human VH3-23 alleles comprising SNP rs56069819 (such alleles denonted "C" and the most frequent allele (which does not comprise this SNP) denoted "A"). The figure shows that VH3-23 alleles comprising SNP rs56069819 are present at a cumulative frequency of 11% across all human ethnic populations taken as a whole, whereas in certain specific human ethnic sub-populations (ASW, LWK, YRI, CEU and GBR) such alleles are present at an above-average cumulative frequency. Indicated in the figure are those human PCSK9 variant forms (marked "Variants") that are found in the various sub-populations with above-average occurrence of human VH3-23 alleles comprising SNP rs56069819. Table 6 shows the VH3-23 variants and the SNPs that they comprise, as well as their cumulative allele frequencies as found in the 1000 Genomes Project database.

[0677] Notably, human VH3-23 alleles comprising SNP rs56069819 were found in the CEU population at a frequency that is almost double the frequency of 11% for all populations. For the ASW and YRI populations the frequency was over a quarter of the population. Thus, the invention advantageously enables one to select a ligand comprising an antibody or antibody fragment, wherein the antibody or fragment comprises a VH domain derived from the recombination of a human VH gene segment, a human D gene segment and a human JH gene segment, the VH gene segment comprising a nucleotide sequence that comprises SNP rs56069819 (dbSNP numbering, build number as recited above).

[0678] In an example, one can tailor the treatment further by selecting such a ligand that specifically binds to a human PCSK9 selected from forms : *f, c, m, e, h, p, q* and *aj,* such forms being those appearing in human populations ASW, LWK, YRI, CEU and GBR.

[0679] In an example, the VH gene segment is VH3-23*04, which is a commonly found variant that comprises SNP rs56069819 in human populations ASW, LWK, YRI, CEU and GBR.

[0680] In an example, the ligand is for treating and/or preventing a PCSK9-mediated disease or condition in a human that expresses a human PCSK9 selected from forms : *f, c, m, e, h, p, q* and *aj.*

[0681] In an example, the ligand is for treating and/or preventing a PCSK9-mediated disease or condition in a human of ASW, LWK, YRI, CEU or GBR ancestry.

[0682] In an embodiment, the ligand is for treating and/or preventing a PCSK9-mediated disease or condition in a human of ASW ancestry, wherein the human expresses a PCSK9 selected from *f, c, m, e, h, and q* or the human comprises a corresponding nucleotide or amino acid sequence as set out in Table 5. Optionally this ligand comprises a VH domain derived from recombination of human VH3-23*04.

[0683] In an embodiment, the ligand is for treating and/or preventing a PCSK9-mediated disease or condition in a

human of LWK ancestry, wherein the human expresses a PCSK9 selected from *f, c, m, e* and *h* or the human comprises a corresponding nucleotide or amino acid sequence as set out in Table 5. Optionally this ligand comprises a VH domain derived from recombination of human VH3-23*04.

[0684] In an embodiment, the ligand is for treating and/or preventing a PCSK9-mediated disease or condition in a human of YRI ancestry, wherein the human expresses a PCSK9 selected from *f, c, m, e* and *h* or the human comprises a corresponding nucleotide or amino acid sequence as set out in Table 5. Optionally this ligand comprises a VH domain derived from recombination of human VH3-23*04.

[0685] In an embodiment, the ligand is for treating and/or preventing a PCSK9-mediated disease or condition in a human of CEU ancestry, wherein the human expresses a PCSK9 selected from *f, c, p* and *aj* or the human comprises a corresponding nucleotide or amino acid sequence as set out in Table 5. Optionally this ligand comprises a VH domain derived from recombination of human VH3-23*04.

[0686] In an embodiment, the ligand is for treating and/or preventing a PCSK9-mediated disease or condition in a human of GBR ancestry, wherein the human expresses a PCSK9 selected from *f*, *c* and *p* or the human comprises a corresponding nucleotide or amino acid sequence as set out in Table 5. Optionally this ligand comprises a VH domain derived from recombination of human VH3-23*04.

[0687] For example in any aspect, example, embodiment or configuration of the invention, the anti-TOI (eg, PCSK9 or IL4Ra) ligand (eg, trap, antibody or fragment) comprises a VH domain derived from the recombination of a human VH segment (eg, human VH3-23*04), a human D gene segment and a human JH segment, the human VH segment encoding the framework 1 of SEQ ID NO: 40 and wherein said human comprises a VH gene segment encoding the framework 1 of SEQ ID NO: 40 , or the human expresses VH domains that comprise the framework 1 of SEQ ID NO: 40. In an alternative, the ligand comprises a VH domain derived from the recombination of a human VH segment (eg, human VH3-23*04), a human D gene segment and a human JH segment, the human VH segment comprising SNP rs56069819 and wherein said human comprises a VH gene segment comprising SNP rs56069819.

[0688] SNP rs56069819 is present in humans at an average cumulative frequency of 11% according to the 1000 Genomes Phase I database, but is higher in AFR (23%), EUR (13%), ASW (27%), LWK (15%), YRI (28%), CEU (19%) and GBR (15%) populations, thus in an embodiment when an anti-TOI (eg, PCSK9 or IL4Ra) antibody or fragment comprises framework 1 of SEQ ID NO: 40 or comprises a VH domain derived from the recombination of a human VH segment (eg, human VH3-23*04), a human D gene segment and a human JH segment, the human VH segment comprising SNP rs56069819, the human is of an ancestry selected from the group consisting of AFR, EUR, ASW, LWK, YRI, CEU and GBR ancestry. For example, the human is of AFR ancestry. For example, the human is of EUR ancestry. For example, the human is of ASW ancestry. For example, the human is of LWK ancestry. For example, the human is of YRI ancestry. For example, the human is of CEU ancestry. For example, the human is of GBR ancestry. In an example, the selected ancestry of the human is one of these listed ancestries and the TOI comprises an amino acid variation (mutation) that is encoded by a SNP that is also present in such a human population at a higher than average cumulative frequency according to the 1000 Genomes. For example, the ligand (eg, antibody or fragment) specifically binds an IL4R protein that comprises a mutation S752A and the human is of YRI ancestry. In this case, the SNP encoding the mutation, as well as SNP rs56069819 are present in the YRI population at an above average cumulative frequency. This general aspect of the invention is therefore particularly useful for tailoring to the genomic profiles of members of such a population.

[0689] In an example the ligand specifically binds to human PCSK9 form *f*.

[0690] In an example the human expresses a human PCSK9 selected from forms: *f, e, p,* and *aj.*

[0691] In an example the human is of ASW, LWK, YRI, CEU or GBR ancestry.

[0692] In an example the human is of ASW ancestry and the human expresses a human PCSK9 selected from forms: *f, e, p* and *aj;* optionally the ligand comprises a VH domain derived from recombination of human VH3-23*04.

[0693] In an example the human is of LWK ancestry and the human expresses a human PCSK9 selected from forms: *f, e, p* and *aj;* optionally the ligand comprises a VH domain derived from recombination of human VH3-23*04.

[0694] In an example the human is of YRI ancestry and the human expresses a human PCSK9 selected from forms: *f, e, p* and *aj;* optionally the ligand comprises a VH domain derived from recombination of human VH3-23*04.

[0695] In an example the human is of CEU ancestry and the human expresses a human PCSK9 selected from forms: *f, e, p* and *aj;* optionally the ligand comprises a VH domain derived from recombination of human VH3-23*04.

[0696] In an example the human is of GBR ancestry and the human expresses a human PCSK9 selected from forms: *f, e, p* and *aj;* optionally the ligand comprises a VH domain derived from recombination of human VH3-23*04.

[0697] In an example the genome of the human comprises a nucleotide sequence selected from the group consisting of SEQ ID NOs: 29, 32, 34 and 36, wherein the antibody or fragment specifically binds to a human PCSK9 selected from forms : *f, e, p and aj* respectively, wherein the antibody or fragment comprises a VH domain derived from the recombination of a human VH gene segment, a human D gene segment and a human JH gene segment, the VH gene segment comprising a nucleotide sequence that comprises SEQ ID NO: 39 or its complement. Optionally wherein VH gene segment is VH3-23*04 (SEQ ID NO: 38).

[0698] In an example, the ligand is alirocumab.

[0699] In other embodiments, as explained more fully above, the invention provides for ligands which are tailored to the human recipient's genotype and/or phenotype based on alternative human VH gene segments, or on Vκ, Vλ or constant region gene segments (see further Table 8 for representative variants).

[0700] For example, the ligand of the invention comprises or consists of an antibody that comprises a VH domain that is derived from the recombination of a human VH gene segment, a human D gene segment and a human JH gene segment, wherein the VH gene segment is selected from the group consisting of (i) IGHV1-18*01 and the genome of the human comprises a human IGHV1-18*01 nucleotide sequence or the human expresses antibodies comprising variable domains derived from the recombination of human IGHV1-18*01; or (ii) IGVH1-46*01 and the genome of the human comprises a human IGHV1-46*01 nucleotide sequence or the human expresses antibodies comprising variable domains derived from the recombination of human IGHV1-46*01.

[0701] For example, the ligand of the invention comprises or consists of an antibody that comprises a VL domain that is derived from the recombination of a human VL gene segment and a human JL gene segment, wherein the VL gene segment is selected from the group consisting of (i) IGKV4-1*01 and the genome of the human comprises a human IGKV4-1*01 nucleotide sequence or the human expresses antibodies comprising variable domains derived from the recombination of human IGKV4-1*01; (ii) IGLV2-14*01 and the genome of the human comprises a human IGLV2-14*01 nucleotide sequence or the human expresses antibodies comprising variable domains derived from the recombination of human IGLV2-14*01; or (iii) IGKV1-13*02 and the genome of the human comprises a human IGKV1-13*02 nucleotide sequence or the human expresses antibodies comprising variable domains derived from the recombination of human IGKV1-13*02.

[0702] For example, the inventor identified the possibility of addressing the rarer IGH-gamma-1 SNPs 204D (observed cumulative frequency of 0.296) and 206L (observed cumulative frequency of 0.283) individually or in combination. These residues are part of the CH3 domain, and as such they form part of antibody Fc regions. Thus, matching of these CH3 variations with the patient is especially beneficial for reasons as discussed above. Thus, in this example the ligand of the invention comprises or consists of an antibody that comprises a human gamma-1 heavy chain constant region that comprises an Asp corresponding to position 204 of SEQ ID NO: 42 or a Leu corresponding to position 206 of SEQ ID NO: 42 and wherein the genome of the human comprises a gamma-1 heavy chain constant region nucleotide sequence that encodes such an Asp or Leu or the human expresses antibodies comprising human gamma-1 constant regions comprising such an Asp or Leu. An example of such a ligand is alirocumab.

[0703] In another example, the inventor identified the possibility of addressing IGH-gamma-2 SNPs. This included consideration of Fc region variation - in this respect, the inventor focused on positions 161 and 257 which are in the Fc region. Thus, in this example the ligand of the invention comprises or consists of an antibody that comprises a human gamma-2 heavy chain constant region that comprises an amino acid selected from the group consisting of a Pro corresponding to position 72 of SEQ ID NO: 44, an Asn corresponding to position 75 of SEQ ID NO: 44, a Phe corresponding to position 76 of SEQ ID NO: 44, a Val corresponding to position 161 of SEQ ID NO: 44 and an Ala corresponding to position 257 of SEQ ID NO: 44; and wherein the genome of the human comprises a gamma-2 heavy chain constant region nucleotide sequence that encodes such a selected amino acid or the human expresses antibodies comprising human gamma-2 constant regions comprising such a selected amino acid. An example of such a ligand is evolocumab or bococizumab.

[0704] In another example, the inventor addressed human kappa constant region variation. Thus, in this example the ligand of the invention comprises or consists of an antibody that comprises a human kappa light chain constant region that comprises a Val corresponding to position 84 of SEQ ID NO: 50 or a Cys corresponding to position 87 of SEQ ID NO: 50; and wherein the genome of the human comprises a kappa light chain constant region nucleotide sequence that encodes such a Val or Cys or the human expresses antibodies comprising human kappa light chain constant regions comprising such a Val or Cys. An example of such a ligand is alirocumab or bococizumab.

[0705] In another example, the inventor addressed human lambda constant region variation. Thus, in this example the ligand of the invention comprises or consists of an antibody that comprises a human IGLC2*01 light chain constant region; and wherein the genome of the human comprises a human IGLC2*01 nucleotide sequence or the human expresses antibodies comprising human light chain IGLC2*01 constant regions. An example of such a ligand is evolocumab.

Example 2: Determination of Specific Binding of Ligands of the Invention to PCSK9 Variants

Method of SPR Determination of Binding

[0706] Binding of the antibodies to the PCSK9 variants was carried out by SPR using the ProteOn XPR36™ Array system (BioRad). An anti-human IgG surface (Jackson Labs 109-005-008) was created on a GLC Biosensor chip by primary amine coupling. Test antibodies were captured on this surface as ligands. The PCSK9 variants were used as analytes and passed over the captured antibodies at 256nM, 64nM, 16nM, 4nM and 1nM. Binding curves were double

referenced using a buffer injection (i.e. 0nM) to remove baseline drift and injection artefacts. Regeneration of the capture surface was with 100mM phosphoric acid which removed the captured antibody allowing another cycle of capture and binding. The binding sensorgrams generated were analysed using the 1:1 model inherent to the ProteOn XPR36 Array system analysis software. The assay was performed at 25 °C and using 1xHBS-EP (Teknova) as running buffer.

Data

[0707] Three antibodies were tested and the resulting binding data are presented below (Table 3). Antibodies 316P and 31H4 are antibodies disclosed in US20110065902A1 (the sequences of these antibodies and their variable domains are incorporated herein by reference for possible use in the present invention and possible inclusion in claims herein). Antibody 316P comprises heavy chain variable domains derived from recombination of human VH3-23*04 and JH2*01 (with a D), and light chain variable domains derived from recombination of human Vκ4-1*01 and Jκ2*01.

[0708] Evolocumab comprises a human IGHG2*01 heavy chain and a human IGLC2*01 lambda light chain, a VH derived from recombination of human IGHV1-18*01 and IGHJ6*01 (with a D segment) and a Vλ derived from recombination of human IGLV2-14*01 and IGU2*01.

Table 3: SPR Determination of Ligand Binding Specificity for PCSK9 Variants

Variant/Antibody	ka (1/Ms)	kd (1/s)	KD (nM)
PCSK9 a			
316P	1.37E+06	2.75E-04	0.201
31H4	1.14E+06	6.38E-05	0.056
Evolocumab	1.14E+05	2.62E-05	0.229
PCSK9 a'			
316P	1.50E+06	2.72E-04	0.181
31H4	1.23E+06	6.06E-05	0.049
Evolocumab	1.24E+05	2.29E-05	0.185
PCSK9 c			
316P	1.49E+06	2.75E-04	0.184
31H4	1.22E+06	5.69E-05	0.047
Evolocumab	1.20E+05	2.20E-05	0.183
PCSK9 r			
316P	1.40E+06	2.76E-04	0.197
31H4	1.15E+06	5.82E-05	0.051
Evolocumab	1.16E+05	2.67E-05	0.230
PCSK9 f			
316P	1.39E+06	2.82E-04	0.203
31H4	1.13E+06	5.95E-05	0.053
Evolocumab	1.16E+05	2.66E-05	0.229
PCSK9 p			
316P	1.39E+06	2.73E-04	0.196
31H4	1.14E+06	6.12E-05	0.054
Evolocumab	1.14E+05	2.50E-05	0.219

Results

[0709] The results showed that all antibodies tested bound to PCSK9 variants equally, with any binding variation seen

being within experimental error for such a strong affinity interaction.

[0710] Thus, the invention determines that an antibody with the following profile can specifically bind one or more variants of the invention:-

1. An antibody (eg, 316P or alirocumab) that comprises heavy chain variable domains derived from recombination of human IGHV3-23*04 and IGHJH2*01 (with a D), and light chain variable domains derived from recombination of human IGKV4-1*01 and IGKJ2*01; or

2. An antibody (eg, evolocumab) that comprises human heavy chain variable domains derived from recombination of human IGHV1-18*01 and IGHJ6*01 (with a D segment) and light chain variable domains derived from recombination of human IGLV2-14*01 and IGLJ2*01.

[0711] Thus, according to the invention, the skilled person is hereby provided with the required determination of specific binding of the ligand to PCSK9 variants. Applications of this determination are set out above in the context of methods and other aspects of the invention.

References:

[0712] The references cited herein are incorporated by reference in their entirety.

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Table 4: 1000 GENOMES PROJECT HUMAN POPULATIONS

[0713] Below is a summary of the ethnic populations as per the 1000 Genomes Project sequences.

Population

[0714]

European ancestry

Utah residents (CEPH) with Northern and Western European ancestry (CEU)

Toscani in Italia (TSI)

British from England and Scotland (GBR)

Finnish from Finland (FIN)

Iberian populations in Spain (IBS)

East Asian ancestry

Han Chinese in Beijing, China (CHB)

Japanese in Toyko, Japan (JPT)

Han Chinese South (CHS)

Chinese Dai in Xishuangbanna (CDX)

Kinh in Ho Chi Minh City, Vietnam (KHV)

Chinese in Denver, Colorado (CHD) (pilot 3 only)

West African ancestry

Yoruba in Ibadan, Nigeria (YRI)

Luhya in Webuye, Kenya (LWK)

Gambian in Western Division, The Gambia (GWD)

Population

[0715]

Malawian in Blantyre, Malawi (MAB)

West African Population (TBD)

Americas

African Ancestry in Southwest US (ASW)

African American in Jackson, MS (AJM)

African Caribbean in Barbados (ACB)

Mexican Ancestry in Los Angeles, CA (MXL)

Puerto Rican in Puerto Rico (PUR)

Colombian in Medellin, Colombia (CLM)

Peruvian in Lima, Peru (PEL)

South Asian ancestry

Ahom in the State of Assam, India

Kayadtha in Calcutta, India

Reddy in Hyderabad, India

Maratha in Bombay, India

Punjabi in Lahore, Pakistan

Table 5: PCSK9 SEQUENCES

FORM/ALLELE	VERSION	SEQUENCE	SEQ ID NO:
AMINO ACID SEQUENCES *Italics* = signal sequence 1-30 Courier = pro peptide 31-152 lower case = catalytic domain 153-449 UPPER CASE = C-terminal domain 450-692 Underlined = residues changed from allele *a* in other sequences (aa residue number shown)			
a	Pro-Form with Signal Sequence	46 53 *MGTVSSRRSWWPLPLLLLLLLLLGPAGARA*QEDEDGDYEELVLALRSEEDGLAEAPEHGTTATFHRCAKDP WRLPGTYVVVLKEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH VDYIEEDSSVFAQsipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvaalppsthGAGWQLFCRTVWSAHSGPTRMATAIARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEEAVTAVAICCRSRHLAQASQELQ	1
a	Pro-Form	QEDEDGDYEELVLALRSEEDGLAEAPEHGTTATFHRCAKDP WRLPGTYVVVLKEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH VDYIEEDSSVFAQsipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvaalppsthGAGWQLFCRTVWSAHSGPTRMATAIARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT	2

		619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEEAVTAVAICCRSRHLAQASQELQ	
a	Mature form	sipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvaalppsthGAGWQLFCRTVWSAHSGPTRMATAIARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEEAVTAVAICCRSRHLAQASQELQ	3
f	Pro-Form with Signal Sequence	46 53 *MGTVSSRRSWWPLPLLLLLLLLLGPAGARA*QEDEDGDYEELVLALRSEEDGLAEAPEHGTTATFHRCAKDP WRLPGTYVVVLKEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH VDYIEEDSSVFAQsipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvaalppsthGAGWQLFCRTVWSAHSGPTRMATAVARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEEAVTAVAICCRSRHLAQASQELQ	4
f	Pro-Form	QEDEDGDYEELVLALRSEEDGLAEAPEHGTTATFHRCAKDP WRLPGTYVVVLKEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH VDYIEEDSSVFAQsipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474	5

		dvineawfpedqrvltpnlvaalppsthGAGWQLFCRTVWSAHSGPTRMATA**V**ARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEEAVTAVAICCRSRHLAQASQELQ	
f, p, aj	Mature form	sipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvaalppsthGAGWQLFCRTVWSAHSGPTRMATA**V**ARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEEAVTAVAICCRSRHLAQASQELQ	6
c	Pro-Form with Signal Sequence	46 53 *MGTVSSRRSWWPLPLLLLLLLLLGPAGARA*QEDEDGDYEELVLALRSEEDGLAEAPEHGTTATFHRCAKDP WRLPGTYVVVLKEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH VDYIEEDSSVFAQsipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvaalppsthGAGWQLFCRTVWSAHSGPTRMATA**I**ARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSE**G**AVTAVAICCRSRHLAQASQELQ	7
c	Pro-Form	QEDEDGDYEELVLALRSEEDGLAEAPEHGTTATFHRCAKDP WRLPGTYVVVLKEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH VDYIEEDSSVFAQsipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly	8

		spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvaalppsthGAGWQLFCRTVWSAHSGPTRMATAIARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEGAVTAVAICCRSRHLAQASQELQ	
c, q	Mature form	sipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvaalppsthGAGWQLFCRTVWSAHSGPTRMATAIARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEGAVTAVAICCRSRHLAQASQELQ	9
r	Pro-Form with Signal Sequence	46 53 *MGTVSSRRSWWPLPLLLLLLLLLGPAGARA*QEDEDGDYEELVLALRSEEDGLAEAPEHGTTATFHRCAKDP WRLPGTYVVVLKEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH VDYIEEDSSVFAQsipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvaalppsthGAGWQLFCRTVWSAHSGPTRMATAVARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEGAVTAVAICCRSRHLAQASQELQ	10
r	Pro-Form	QEDEDGDYEELVLALRSEEDGLAEAPEHGTTATFHRCAKDP WRLPGTYVVVLKEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH	11

		VDYIEEDSSVFAQsipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvaalppsthGAGWQLFCRTVWSAHSGPTRMATA**V**ARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSE**G**AVTAVAICCRSRHLAQASQELQ	
r	Mature form	sipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvaalppsthGAGWQLFCRTVWSAHSGPTRMATA**V**ARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSE**G**AVTAVAICCRSRHLAQASQELQ	12
p	Pro-Form with Signal Sequence	46 53 *MGTVSSRRSWWPLPLLLLLLLLLGPAGARA*QEDEDGDYEELVLALRSEEDGL**V**EAPEHGTTATFHRCAKDP WRLPGTYVVVLKEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH VDYIEEDSSVFAQsipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvaalppsthGAGWQLFCRTVWSAHSGPTRMATA**V**ARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEEAVTAVAICCRSRHLAQASQELQ	13

p	Pro-Form	QEDEDGDYEELVLALRSEEDGLVEAPEHGTTATFHRCAKDP WRLPGTYVVVLKEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH VDYIEEDSSVFAQsipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvaalppsthGAGWQLFCRTVWSAHSGPTRMATAVARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEEAVTAVAICCRSRHLAQASQELQ	14
m	Pro-Form with Signal Sequence	46 53 *MGTVSSRRSWWPLPLLLLLLLLLGPAGARA*QEDEDGDYEELVLALRSEEDGLAEAPEHGTTATFHRCAKDP WRLPGTYVVVLKEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH VDYIEEDSSVFAQsipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvatlppsthGAGWQLFCRTVWSAHSGPTRMATAIARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEEAVTAVAICCRSRHLAQASQELQ	15
m	Pro-Form	QEDEDGDYEELVLALRSEEDGLAEAPEHGTTATFHRCAKDP WRLPGTYVVVLKEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH VDYIEEDSSVFAQsipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvatlppsthGAGWQLFCRTVWSAHSGPTRMATAIARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620	16

		HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEEAVTAVAICCRSRHLAQASQELQ	
m	Mature form	sipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvatlppsthGAGWQLFCRTVWSAHSGPTRMATAIARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEEAVTAVAICCRSRHLAQASQELQ	17
e	Pro-Form with Signal Sequence	46 53 *MGTVSSRRSWWPLPLLLLLLLLLGPAGARA*QEDEDGDYEELVLALRSEEDGLAEAPEHGTTATFHRCAKDP WRLPGTYVVVLKEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH VDYIEEDSSVFAQsipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvi<u>s</u>eawfpedqrvltpnlva<u>a</u>lppsthGAGWQLFCRTVWSAHSGPTRMATA<u>V</u>ARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEEAVTAVAICCRSRHLAQASQELQ	18
e	Pro-Form	QEDEDGDYEELVLALRSEEDGLAEAPEHGTTATFHRCAKDP WRLPGTYVVVLKEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH VDYIEEDSSVFAQsipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvi<u>s</u>eawfpedqrvltpnlva<u>a</u>lppsthGAGWQLFCRTVWSAHSGPTRMATA<u>V</u>ARCAPDEELLSCSSFSRSGKRRGERM	19

		EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEEAVTAVAICCRSRHLAQASQELQ	
e	Mature form	sipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dviseawfpedqrvltpnlvaalppsthGAGWQLFCRTVWSAHSGPTRMATAVARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEEAVTAVAICCRSRHLAQASQELQ	20
h	Pro-Form with Signal Sequence	46 53 *MGTVSSRRSWWPLPLLLLLLLLLGPAGARA*QEDEDGDYEELVLALRSEEDGLAEAPEHGTTATFHRCAKDP WRLPGTYVVVLKEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH VDYIEEDSSVFAQsipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvatlppsthGAGWQLFCRTVWSAHSGPTRMATAIARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPPEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEEAVTAVAICCRSRHLAQASQELQ	21
h	Pro-Form	QEDEDGDYEELVLALRSEEDGLAEAPEHGTTATFHRCAKDP WRLPGTYVVVLKEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH VDYIEEDSSVFAQsipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak	22

		425 443 474 dvineawfpedqrvltpnlvatlppsthGAGWQLFCRTVWSAHSGPTRMATAIARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPPEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEEAVTAVAICCRSRHLAQASQELQ	
h	Mature form	sipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvatlppsthGAGWQLFCRTVWSAHSGPTRMATAIARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPPEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEEAVTAVAICCRSRHLAQASQELQ	23
aj	Pro-Form with Signal Sequence	46 53 *MGTVSSRRSWWPLPLLLLLLLLLGPAGARAQEDEDGDYEELVLALLSEEDGLAEAPEHGTTATFHRCAKDP* WRLPGTYVVVLKEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH VDYIEEDSSVFAQsipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvaalppsthGAGWQLFCRTVWSAHSGPTRMATAVARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEEAVTAVAICCRSRHLAQASQELQ	24
aj	Pro-Form	QEDEDGDYEELVLALLSEEDGLAEAPEHGTTATFHRCAKDP WRLPGTYVVVLKEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH VDYIEEDSSVFAQsipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg	25

		thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvaalppsthGAGWQLFCRTVWSAHSGPTRMATAVARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEEAVTAVAICCRSRHLAQASQELQ	
q	Pro-Form with Signal Sequence	46 53 *MGTVSSRRSWWPLPLLLLLLLLLGPAGARA*QEDEDGDYEELVLALRSEEDGLVEAPEHGTTATFHRCAKDP WRLPGTYVVVLKEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH VDYIEEDSSVFAQsipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvaalppsthGAGWQLFCRTVWSAHSGPTRMATAIARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEGAVTAVAICCRSRHLAQASQELQ	26
q	Pro-Form	QEDEDGDYEELVLALRSEEDGLVEAPEHGTTATFHRCAKDP WRLPGTYVVVLKEETHLSQSERTARRLQAQAARRGYLTKILHVFHGLLPGFLVKMSGDLLELALKLPH VDYIEEDSSVFAQsipwnleritppryradeyqppdggslvevylldtsiqsdhreiegrvmvtdfenvpeedgtrfhrqaskcdshg thlagvvsgrdagvakgasmrslrvlncqgkgtvsgtliglefirksqlvqpvgplvvllplaggysrvlnaacqrlaragvvlvtaagnfrddacly spasapevitvgatnaqdqpvtlgtlgtnfgrcvdlfapgediigassdcstcfvsqsgtsqaaahvagiaammlsaepeltlaelrqrlihfsak 425 443 474 dvineawfpedqrvltpnlvaalppsthGAGWQLFCRTVWSAHSGPTRMATAIARCAPDEELLSCSSFSRSGKRRGERM EAQGGKLVCRAHNAFGGEGVYAIARCCLLPQANCSVHTAPPAEASMGTRVHCHQQGHVLTGCSSHWEVEDLGT 619 620 HKPPVLRPRGQPNQCVGHREASIHASCCHAPGLECKVKEHGIPAPQEQVTVACEEGWTLTGCSALPGTSHVLGAY 670 AVDNTCVVRSRDVSTTGSTSEGAVTAVAICCRSRHLAQASQELQ	27

NUCLEOTIDE SEQUENCES *Italics* = nucleotide sequence encoding signal sequence (nucleotides 1-90) `Courier` = nucleotide sequence encoding pro peptide (nucleotides 91-456) lower case = nucleotide sequence encoding catalytic domain (nucleotides 457-1346) UPPER CASE = nucleotide sequence encoding C-terminal domain (nucleotides 1347-2076)			
a		*ATGGGCACCGTCAGCTCCAGGCGGTCCTGGTGGCCGCTGCCACTGCTGCTGCTGCTGCTGCTCCTGGGTC* R46L CGT to CTT *CCGCGGGCGCCCGTGCG*CAGGAGGACGAGGACGGCGACTACGAGGAGCTGGTGCTAGCCTTGCGTTCCG A53V GCC to GTC AGGAGGACGGCCTGGCCGAAGCACCCGAGCACGGAACCACAGCCACCTTCCACCGCTGCGCCAAGGAT CCGTGGAGGTTGCCTGGCACCTACGTGGTGGTGCTGAAGGAGGAGACCCACCTCTCGCAGTCAGAGCG CACTGCCCGCCGCCTGCAGGCCCAGGCTGCCCGCCGGGGATACCTCACCAAGATCCTGCATGTCTTCC ATGGCCTTCTTCCTGGCTTCCTGGTGAAGATGAGTGGCGACCTGCTGGAGCTGGCCTTGAAGTTGCCC CATGTCGACTACATCGAGGAGGACTCCTCTGTCTTTGCCCAGagcatcccgtggaacctggagcggattacccctcca cggtaccgggcggatgaataccagccccccgacggaggcagcctggtggaggtgtatctcctagacaccagcatacagagtgaccaccgggaa atcgagggcagggtcatggtcaccgacttcgagaatgtgcccgaggaggacgggacccgcttccacagacaggccagcaagtgtgacagtcat ggcacccacctggcaggggtggtcagcggccgggatgccggcgtggccaagggtgccagcatgcgcagcctgcgcgtgctcaactgccaaggg aagggcacggttagcggcaccctcataggcctggagtttattcggaaaagccagctggtccagcctgtggggccactggtggtgctgctgcccct ggcgggtgggtacagccgcgtcctcaacgccgcctgccagcgcctggcgagggctggggtcgtgctggtcaccgctgccggcaacttccgggac gatgcctgcctctactccccagcctcagctcccgaggtcatcacagttggggccaccaatgcccaagaccagccggtgaccctggggactttggg gaccaactttggccgctgtgtggacctctttgccccaggggaggacatcattggtgcctccagcgactgcagcacctgctttgtgtcacagagtgg gacatcacaggctgctgcccacgtggctggcattgcagccatgatgctgtctgccgagccggagctcaccctggccgagttgaggcagagactg N425S AAT to AGT A443T GCC to ACC atccacttctctgccaaagatgtcatcaatgaggcctggttccctgaggaccagcgggtactgacccccaacctggtggccgccctgccccccag cacccatGGGGCAGGTTGGCAGCTGTTTTGCAGGACTGTATGGTCAGCACACTCGGGGCCTACACGGATGGCC I474V ATC to GTC ACAGCCATCGCCCGCTGCGCCCCAGATGAGGAGCTGCTGAGCTGCTCCAGTTTCTCCAGGAGTGGGAAGCGG CGGGGCGAGCGCATGGAGGCCCAAGGGGGCAAGCTGGTCTGCCGGGCCCACAACGCTTTTGGGGGTGAGGG TGTCTACGCCATTGCCAGGTGCTGCCTGCTACCCCAGGCCAACTGCAGCGTCCACACAGCTCCACCAGCTGAG GCCAGCATGGGGACCCGTGTCCACTGCCACCAACAGGGCCACGTCCTCACAGGCTGCAGCTCCCACTGGGAG GTGGAGGACCTTGGCACCCACAAGCCGCCTGTGCTGAGGCCACGAGGTCAGCCCAACCAGTGCGTGGGCCAC	28

		AGGGAGGCCAGCATCCACGCTTCCTGCTGCCATGCCCCAGGTCTGGAATGCAAAGTCAAGGAGCATGGAA Q619P CAG to CCG E620G GAG to GGG TCCCGGCCCCTCAGGAGCAGGTGACCGTGGCCTGCGAGGAGGGCTGGACCCTGACTGGCTGCAGTGCCCTCC CTGGGACCTCCCACGTCCTGGGGGCCTACGCCGTAGACAACACGTGTGTAGTCAGGAGCCGGGACGTCAGCA E670G GAG to GGG CTACAGGCAGCACCAGCGAAGAGGCCGTGACAGCCGTTGCCATCTGCTGCCGGAGCCGGCACCTGGCGCAGG CCTCCCAGGAGCTCCAGTGAC	
f		*ATGGGCACCGTCAGCTCCAGGCGGTCCTGGTGGCCGCTGCCACTGCTGCTGCTGCTGCTGCTCCTGGGTC* R46L CGT to CTT *CCGCGGGCGCCCGTGCG*CAGGAGGACGAGGACGGCGACTACGAGGAGCTGGTGCTAGCCTTGCGTTCCG A53V GCC to GTC AGGAGGACGGCCTGGCCGAAGCACCCGAGCACGGAACCACAGCCACCTTCCACCGCTGCGCCAAGGAT CCGTGGAGGTTGCCTGGCACCTACGTGGTGGTGCTGAAGGAGGAGACCCACCTCTCGCAGTCAGAGCG CACTGCCCGCCGCCTGCAGGCCCAGGCTGCCCGCCGGGGATACCTCACCAAGATCCTGCATGTCTTCC ATGGCCTTCTTCCTGGCTTCCTGGTGAAGATGAGTGGCGACCTGCTGGAGCTGGCCTTGAAGTTGCCC CATGTCGACTACATCGAGGAGGACTCCTCTGTCTTTGCCCAGagcatcccgtggaacctggagcggattacccctcca cggtaccgggcggatgaataccagcccccgacggaggcagcctggtggaggtgtatctcctagacaccagcatacagagtgaccaccgggaa atcgagggcagggtcatggtcaccgacttcgagaatgtgcccgaggaggacgggacccgcttccacagacaggccagcaagtgtgacagtcat ggcacccacctggcaggggtggtcagcggccgggatgccggcgtggccaagggtgccagcatgcgcagcctgcgcgtgctcaactgccaaggg aagggcacggttagcggcaccctcataggcctggagtttattcggaaaagccagctggtccagcctgtggggccactggtggtgctgctgcccct ggcgggtgggtacagccgcgtcctcaacgccgcctgccagcgcctggcgagggctggggtcgtgctggtcaccgctgccggcaacttccgggac gatgcctgcctctactccccagcctcagctcccgaggtcatcacagttggggccaccaatgcccaagaccagccggtgaccctggggactttggg gaccaactttggccgctgtgtggacctctttgccccaggggaggacatcattggtgcctccagcgactgcagcacctgctttgtgtcacagagtgg gacatcacaggctgctgcccacgtggctggcattgcagccatgatgctgtctgccgagccggagctcaccctggccgagttgaggcagagactg N425S AAT to AGT A443T GCC to ACC atccacttctctgccaaagatgtcatcaatgaggcctggttccctgaggaccagcgggtactgacccccaacctggtggccgccctgccccccag cacccatGGGGCAGGTTGGCAGCTGTTTTGCAGGACTGTATGGTCAGCACACTCGGGGCCTACACGGATGGCC I474V ATC to GTC ACAGCCGTCGCCCGCTGCGCCCCAGATGAGGAGCTGCTGAGCTGCTCCAGTTTCTCCAGGAGTGGGAAGCGG CGGGGCGAGCGCATGGAGGCCCAAGGGGGCAAGCTGGTCTGCCGGGCCCACAACGCTTTTGGGGGTGAGGG TGTCTACGCCATTGCCAGGTGCTGCCTGCTACCCCAGGCCAACTGCAGCGTCCACACAGCTCCACCAGCTGAG GCCAGCATGGGGACCCGTGTCCACTGCCACCAACAGGGCCACGTCCTCACAGGCTGCAGCTCCCACTGGGAG GTGGAGGACCTTGGCACCCACAAGCCGCCTGTGCTGAGGCCACGAGGTCAGCCCAACCAGTGCGTGGGCCAC AGGGAGGCCAGCATCCACGCTTCCTGCTGCCATGCCCCAGGTCTGGAATGCAAAGTCAAGGAGCATGGAA	29

		Q619P CAG to CCG E620G GAG to GGG TCCCGGCCCCTCAGGAGCAGGTGACCGTGGCCTGCGAGGAGGGCTGGACCCTGACTGGCTGCAGTGCCCTCC CTGGGACCTCCCACGTCCTGGGGGCCTACGCCGTAGACAACACGTGTGTAGTCAGGAGCCGGGACGTCAGCA E670G GAG to GGG CTACAGGCAGCACCAGCGAAGAGGCCGTGACAGCCGTTGCCATCTGCTGCCGGAGCCGGCACCTGGCGCAGG CCTCCCAGGAGCTCCAGTGAC	
c		*ATGGGCACCGTCAGCTCCAGGCGGTCCTGGTGGCCGCTGCCACTGCTGCTGCTGCTGCTGCTCCTGGGTC* R46L CGT to CTT *CCGCGGGCGCCCGTGCG*CAGGAGGACGAGGACGGCGACTACGAGGAGCTGGTGCTAGCCTTGCGTTCCG A53V GCC to GTC AGGAGGACGGCCTGGCCGAAGCACCCGAGCACGGAACCACAGCCACCTTCCACCGCTGCGCCAAGGAT CCGTGGAGGTTGCCTGGCACCTACGTGGTGGTGCTGAAGGAGGAGACCCACCTCTCGCAGTCAGAGCG CACTGCCCGCCGCCTGCAGGCCCAGGCTGCCCGCCGGGGATACCTCACCAAGATCCTGCATGTCTTCC ATGGCCTTCTTCCTGGCTTCCTGGTGAAGATGAGTGGCGACCTGCTGGAGCTGGCCTTGAAGTTGCCC CATGTCGACTACATCGAGGAGGACTCCTCTGTCTTTGCCCAGagcatcccgtggaacctggagcggattacccctcca cggtaccgggcggatgaataccagcccccgacggaggcagcctggtggaggtgtatctcctagacaccagcatacagagtgaccaccgggaa atcgagggcagggtcatggtcaccgacttcgagaatgtgcccgaggaggacgggacccgcttccacagacaggccagcaagtgtgacagtcat ggcacccacctggcaggggtggtcagcggccgggatgccggcgtggccaagggtgccagcatgcgcagcctgcgcgtgctcaactgccaaggg aagggcacggttagcggcaccctcataggcctggagtttattcggaaaagccagctggtccagcctgtggggccactggtggtgctgctgcccct ggcgggtgggtacagccgcgtcctcaacgccgcctgccagcgcctggcgagggctggggtcgtgctggtcaccgctgccggcaacttccgggac gatgcctgcctctactccccagcctcagctcccgaggtcatcacagttggggccaccaatgcccaagaccagccggtgaccctggggactttggg gaccaactttggccgctgtgtggacctctttgccccaggggaggacatcattggtgcctccagcgactgcagcacctgctttgtgtcacagagtgg gacatcacaggctgctgcccacgtggctggcattgcagccatgatgctgtctgccgagccggagctcaccctggccgagttgaggcagagactg N425S AAT to AGT A443T GCC to ACC atccacttctctgccaaagatgtcatcaatgaggcctggttccctgaggaccagcgggtactgacccccaacctggtggccgccctgccccccag cacccatGGGGCAGGTTGGCAGCTGTTTTGCAGGACTGTATGGTCAGCACACTCGGGGCCTACACGGATGGCC I474V ATC to GTC ACAGCCATCGCCCGCTGCGCCCCAGATGAGGAGCTGCTGAGCTGCTCCAGTTTCTCCAGGAGTGGGAAGCGG CGGGGCGAGCGCATGGAGGCCCAAGGGGGCAAGCTGGTCTGCCGGGCCCACAACGCTTTTGGGGGTGAGGG TGTCTACGCCATTGCCAGGTGCTGCCTGCTACCCCAGGCCAACTGCAGCGTCCACACAGCTCCACCAGCTGAG GCCAGCATGGGGACCCGTGTCCACTGCCACCAACAGGGCCACGTCCTCACAGGCTGCAGCTCCCACTGGGAG GTGGAGGACCTTGGCACCCACAAGCCGCCTGTGCTGAGGCCACGAGGTCAGCCCAACCAGTGCGTGGGCCAC AGGGAGGCCAGCATCCACGCTTCCTGCTGCCATGCCCCAGGTCTGGAATGCAAAGTCAAGGAGCATGGAA Q619P CAG to CCG E620G GAG to GGG TCCCGGCCCCTCAGGAGCAGGTGACCGTGGCCTGCGAGGAGGGCTGGACCCTGACTGGCTGCAGTGCCCTCC	30

		CTGGGACCTCCCACGTCCTGGGGGCCTACGCCGTAGACAACACGTGTGTAGTCAGGAGCCGGGACGTCAGCA E670G GAG to GGG CTACAGGCAGCACCAGCGAAGGGGCCGTGACAGCCGTTGCCATCTGCTGCCGGAGCCGGCACCTGGCGCAGG CCTCCCAGGAGCTCCAGTGAC	
r		*ATGGGCACCGTCAGCTCCAGGCGGTCCTGGTGGCCGCTGCCACTGCTGCTGCTGCTGCTGCTCCTGGGTC* R46L CGT to CTT *CCGCGGGCGCCCGTGCG*CAGGAGGACGAGGACGGCGACTACGAGGAGCTGGTGCTAGCCTTGCGTTCCG A53V GCC to GTC AGGAGGACGGCCTGGCCGAAGCACCCGAGCACGGAACCACAGCCACCTTCCACCGCTGCGCCAAGGAT CCGTGGAGGTTGCCTGGCACCTACGTGGTGGTGCTGAAGGAGGAGACCCACCTCTCGCAGTCAGAGCG CACTGCCCGCCGCCTGCAGGCCCAGGCTGCCCGCCGGGGATACCTCACCAAGATCCTGCATGTCTTCC ATGGCCTTCTTCCTGGCTTCCTGGTGAAGATGAGTGGCGACCTGCTGGAGCTGGCCTTGAAGTTGCCC CATGTCGACTACATCGAGGAGGACTCCTCTGTCTTTGCCCAGagcatcccgtggaacctggagcggattacccctcca cggtaccgggcggatgaataccagcccccgacggaggcagcctggtggaggtgtatctcctagacaccagcatacagagtgaccaccgggaa atcgagggcagggtcatggtcaccgacttcgagaatgtgcccgaggaggacgggacccgcttccacagacaggccagcaagtgtgacagtcat ggcacccacctggcaggggtggtcagcggccgggatgccggcgtggccaagggtgccagcatgcgcagcctgcgcgtgctcaactgccaaggg aagggcacggttagcggcaccctcataggcctggagtttattcggaaaagccagctggtccagcctgtggggccactggtggtgctgctgcccct ggcgggtgggtacagccgcgtcctcaacgccgcctgccagcgcctggcgagggctggggtcgtgctggtcaccgctgccggcaacttccgggac gatgcctgcctctactccccagcctcagctcccgaggtcatcacagttggggccaccaatgcccaagaccagccggtgaccctggggactttggg gaccaactttggccgctgtgtggacctctttgccccaggggaggacatcattggtgcctccagcgactgcagcacctgctttgtgtcacagagtgg gacatcacaggctgctgcccacgtggctggcattgcagccatgatgctgtctgccgagccggagctcaccctggccgagttgaggcagagactg N425S AAT to AGT A443T GCC to ACC atccacttctctgccaaagatgtcatcaatgaggcctggttccctgaggaccagcgggtactgacccccaacctggtggccgccctgccccccag cacccatGGGGCAGGTTGGCAGCTGTTTTGCAGGACTGTATGGTCAGCACACTCGGGGCCTACACGGATGGCC I474V ATC to GTC ACAGCCGTCGCCCGCTGCGCCCCAGATGAGGAGCTGCTGAGCTGCTCCAGTTTCTCCAGGAGTGGGAAGCGG CGGGGCGAGCGCATGGAGGCCCAAGGGGGCAAGCTGGTCTGCCGGGCCCACAACGCTTTTGGGGGTGAGGG TGTCTACGCCATTGCCAGGTGCTGCCTGCTACCCCAGGCCAACTGCAGCGTCCACACAGCTCCACCAGCTGAG GCCAGCATGGGGACCCGTGTCCACTGCCACCAACAGGGCCACGTCCTCACAGGCTGCAGCTCCCACTGGGAG GTGGAGGACCTTGGCACCCACAAGCCGCCTGTGCTGAGGCCACGAGGTCAGCCCAACCAGTGCGTGGGCCAC AGGGAGGCCAGCATCCACGCTTCCTGCTGCCATGCCCCAGGTCTGGAATGCAAAGTCAAGGAGCATGGAA Q519P CAG to CCG E620G GAG to GGG TCCCGGCCCCTCAGGAGCAGGTGACCGTGGCCTGCGAGGAGGGCTGGACCCTGACTGGCTGCAGTGCCCTCC CTGGGACCTCCCACGTCCTGGGGGCCTACGCCGTAGACAACACGTGTGTAGTCAGGAGCCGGGACGTCAGCA	31

		E670G GAG to GGG CTACAGGCAGCACCAGCGAAGGGGCCGTGACAGCCGTTGCCATCTGCTGCCGGAGCCGGCACCTGGCGCAGG CCTCCCAGGAGCTCCAGTGAC	
p		*ATGGGCACCGTCAGCTCCAGGCGGTCCTGGTGGCCGCTGCCACTGCTGCTGCTGCTGCTGCTCCTGGGTC* R46L CGT to CTT *CCGCGGGCGCCCGTGCG*CAGGAGGACGAGGACGGCGACTACGAGGAGCTGGTGCTAGCCTTGCGTTCCG A53V GCC to GTC AGGAGGACGGCCTGGTCGAAGCACCCGAGCACGGAACCACAGCCACCTTCCACCGCTGCGCCAAGGAT CCGTGGAGGTTGCCTGGCACCTACGTGGTGGTGCTGAAGGAGGAGACCCACCTCTCGCAGTCAGAGCG CACTGCCCGCCGCCTGCAGGCCCAGGCTGCCCGCCGGGGATACCTCACCAAGATCCTGCATGTCTTCC ATGGCCTTCTTCCTGGCTTCCTGGTGAAGATGAGTGGCGACCTGCTGGAGCTGGCCTTGAAGTTGCCC CATGTCGACTACATCGAGGAGGACTCCTCTGTCTTTGCCCAGagcatcccgtggaacctggagcggattacccctcca cggtaccgggcggatgaataccagcccccgacggaggcagcctggtggaggtgtatctcctagacaccagcatacagagtgaccaccgggaa atcgagggcagggtcatggtcaccgacttcgagaatgtgcccgaggaggacgggacccgcttccacagacaggccagcaagtgtgacagtcat ggcacccacctggcaggggtggtcagcggccgggatgccggcgtggccaagggtgccagcatgcgcagcctgcgcgtgctcaactgccaaggg aagggcacggttagcggcaccctcataggcctggagtttattcggaaaagccagctggtccagcctgtggggccactggtggtgctgctgcccct ggcgggtgggtacagccgcgtcctcaacgccgcctgccagcgcctggcgagggctggggtcgtgctggtcaccgctgccggcaacttccgggac gatgcctgcctctactccccagcctcagctcccgaggtcatcacagttggggccaccaatgcccaagaccagccggtgaccctggggactttggg gaccaactttggccgctgtgtggacctctttgccccaggggaggacatcattggtgcctccagcgactgcagcacctgctttgtgtcacagagtgg gacatcacaggctgctgcccacgtggctggcattgcagccatgatgctgtctgccgagccggagctcaccctggccgagttgaggcagagactg N425S AAT to AGT A443T GCC to ACC atccacttctctgccaaagatgtcatcaatgaggcctggttccctgaggaccagcgggtactgacccccaacctggtggccgccctgcccccccag cacccatGGGGCAGGTTGGCAGCTGTTTTGCAGGACTGTATGGTCAGCACACTCGGGGCCTACACGGATGGCC I474V ATC to GTC ACAGCCGTCGCCCGCTGCGCCCCAGATGAGGAGCTGCTGAGCTGCTCCAGTTTCTCCAGGAGTGGGAAGCGG CGGGGCGAGCGCATGGAGGCCCAAGGGGGCAAGCTGGTCTGCCGGGCCCACAACGCTTTTGGGGGTGAGGG TGTCTACGCCATTGCCAGGTGCTGCCTGCTACCCCAGGCCAACTGCAGCGTCCACACAGCTCCACCAGCTGAG GCCAGCATGGGGACCCGTGTCCACTGCCACCAACAGGGCCACGTCCTCACAGGCTGCAGCTCCCACTGGGAG GTGGAGGACCTTGGCACCCACAAGCCGCCTGTGCTGAGGCCACGAGGTCAGCCCAACCAGTGCGTGGGCCAC AGGGAGGCCAGCATCCACGCTTCCTGCTGCCATGCCCCAGGTCTGGAATGCAAAGTCAAGGAGCATGGAA Q619P CAG to CCG E620G GAG to GGG TCCCGGCCCCTCAGGAGCAGGTGACCGTGGCCTGCGAGGAGGGCTGGACCCTGACTGGCTGCAGTGCCCTCC CTGGGACCTCCCACGTCCTGGGGGCCTACGCCGTAGACAACACGTGTGTAGTCAGGAGCCGGGACGTCAGCA E670G GAG to GGG CTACAGGCAGCACCAGCGAAGAGGCCGTGACAGCCGTTGCCATCTGCTGCCGGAGCCGGCACCTGGCGCAGG	32

		CCTCCCAGGAGCTCCAGTGAC	
m		*ATGGGCACCGTCAGCTCCAGGCGGTCCTGGTGGCCGCTGCCACTGCTGCTGCTGCTGCTGCTCCTGGGTC* R46L CGT to CTT *CCGCGGGCGCCCGTGCG*CAGGAGGACGAGGACGGCGACTACGAGGAGCTGGTGCTAGCCTTGCGTTCCG A53V GCC to GTC AGGAGGACGGCCTGGCCGAAGCACCCGAGCACGGAACCACAGCCACCTTCCACCGCTGCGCCAAGGAT CCGTGGAGGTTGCCTGGCACCTACGTGGTGGTGCTGAAGGAGGAGACCCACCTCTCGCAGTCAGAGCG CACTGCCCGCCGCCTGCAGGCCCAGGCTGCCCGCCGGGGATACCTCACCAAGATCCTGCATGTCTTCC ATGGCCTTCTTCCTGGCTTCCTGGTGAAGATGAGTGGCGACCTGCTGGAGCTGGCCTTGAAGTTGCCC CATGTCGACTACATCGAGGAGGACTCCTCTGTCTTTGCCCAGagcatcccgtggaacctggagcggattacccctcca cggtaccgggcggatgaataccagcccccgacggaggcagcctggtggaggtgtatctcctagacaccagcatacagagtgaccaccgggaa atcgagggcagggtcatggtcaccgacttcgagaatgtgcccgaggaggacgggacccgcttccacagacaggccagcaagtgtgacagtcat ggcacccacctggcaggggtggtcagcggccgggatgccggcgtggccaagggtgccagcatgcgcagcctgcgcgtgctcaactgccaaggg aagggcacggttagcggcaccctcataggcctggagtttattcggaaaagccagctggtccagcctgtggggccactggtggtgctgctgcccct ggcgggtgggtacagccgcgtcctcaacgccgcctgccagcgcctggcgagggctggggtcgtgctggtcaccgctgccggcaacttccgggac gatgcctgcctctactccccagcctcagctcccgaggtcatcacagttggggccaccaatgcccaagaccagccggtgaccctggggactttggg gaccaactttggccgctgtgtggacctctttgccccaggggaggacatcattggtgcctccagcgactgcagcacctgctttgtgtcacagagtgg gacatcacaggctgctgcccacgtggctggcattgcagccatgatgctgtctgccgagccggagctcaccctggccgagttgaggcagagactg N425S AAT to AGT A443T GCC to ACC atccacttctctgccaaagatgtcatcaatgaggcctggttccctgaggaccagcgggtactgacccccaacctggtggccaccctgcccccccag cacccatGGGGCAGGTTGGCAGCTGTTTTGCAGGACTGTATGGTCAGCACACTCGGGGCCTACACGGATGGCC I474V ATC to GTC ACAGCCATCGCCCGCTGCGCCCCAGATGAGGAGCTGCTGAGCTGCTCCAGTTTCTCCAGGAGTGGGAAGCGG CGGGGCGAGCGCATGGAGGCCCAAGGGGGCAAGCTGGTCTGCCGGGCCCACAACGCTTTTGGGGGTGAGGG TGTCTACGCCATTGCCAGGTGCTGCCTGCTACCCCAGGCCAACTGCAGCGTCCACACAGCTCCACCAGCTGAG GCCAGCATGGGGACCCGTGTCCACTGCCACCAACAGGGCCACGTCCTCACAGGCTGCAGCTCCCACTGGGAG GTGGAGGACCTTGGCACCCACAAGCCGCCTGTGCTGAGGCCACGAGGTCAGCCCAACCAGTGCGTGGGCCAC AGGGAGGCCAGCATCCACGCTTCCTGCTGCCATGCCCCAGGTCTGGAATGCAAAGTCAAGGAGCATGGAA Q619P CAG to CCG E620G GAG to GGG TCCCGGCCCCTCAGGAGCAGGTGACCGTGGCCTGCGAGGAGGGCTGGACCCTGACTGGCTGCAGTGCCCTCC CTGGGACCTCCCACGTCCTGGGGGCCTACGCCGTAGACAACACGTGTGTAGTCAGGAGCCGGGACGTCAGCA E670G GAG to GGG CTACAGGCAGCACCAGCGAAGAGGCCGTGACAGCCGTTGCCATCTGCTGCCGGAGCCGGCACCTGGCGCAGG CCTCCCAGGAGCTCCAGTGAC	33
e		*ATGGGCACCGTCAGCTCCAGGCGGTCCTGGTGGCCGCTGCCACTGCTGCTGCTGCTGCTGCTCCTGGGTC*	34

		R46L CGT to CTT *CCGCGGGCGCCCGTGCG*CAGGAGGACGAGGACGGCGACTACGAGGAGCTGGTGCTAGCCTTGCGTTCCG A53V GCC to GTC AGGAGGACGGCCTGGCCGAAGCACCCGAGCACGGAACCACAGCCACCTTCCACCGCTGCGCCAAGGAT CCGTGGAGGTTGCCTGGCACCTACGTGGTGGTGCTGAAGGAGGAGACCCACCTCTCGCAGTCAGAGCG CACTGCCCGCCGCCTGCAGGCCCAGGCTGCCCGCCGGGGATACCTCACCAAGATCCTGCATGTCTTCC ATGGCCTTCTTCCTGGCTTCCTGGTGAAGATGAGTGGCGACCTGCTGGAGCTGGCCTTGAAGTTGCCC CATGTCGACTACATCGAGGAGGACTCCTCTGTCTTTGCCCAGagcatcccgtggaacctggagcggattacccctcca cggtaccgggcggatgaataccagccccccgacggaggcagcctggtggaggtgtatctcctagacaccagcatacagagtgaccaccgggaa atcgagggcagggtcatggtcaccgacttcgagaatgtgcccgaggaggacgggacccgcttccacagacaggccagcaagtgtgacagtcat ggcacccacctggcaggggtggtcagcggccgggatgccggcgtggccaagggtgccagcatgcgcagcctgcgcgtgctcaactgccaaggg aagggcacggttagcggcaccctcataggcctggagtttattcggaaaagccagctggtccagcctgtggggccactggtggtgctgctgcccct ggcgggtgggtacagccgcgtcctcaacgccgcctgccagcgcctggcgagggctggggtcgtgctggtcaccgctgccggcaacttccgggac gatgcctgcctctactccccagcctcagctcccgaggtcatcacagttggggccaccaatgcccaagaccagccggtgaccctggggactttggg gaccaactttggccgctgtgtggacctctttgccccaggggaggacatcattggtgcctccagcgactgcagcacctgctttgtgtcacagagtgg gacatcacaggctgctgcccacgtggctggcattgcagccatgatgctgtctgccgagccggagctcaccctggccgagttgaggcagagactg N425S AAT to AGT A443T GCC to ACC atccacttctctgccaaagatgtcatcagtgaggcctggttccctgaggaccagcgggtactgacccccaacctggtggccgccctgccccccag cacccatGGGGCAGGTTGGCAGCTGTTTTGCAGGACTGTATGGTCAGCACACTCGGGGCCTACACGGATGGCC I474V ATC to GTC ACAGCCGTCGCCCGCTGCGCCCCAGATGAGGAGCTGCTGAGCTGCTCCAGTTTCTCCAGGAGTGGGAAGCGG CGGGGCGAGCGCATGGAGGCCCAAGGGGGCAAGCTGGTCTGCCGGGCCCACAACGCTTTTGGGGGTGAGGG TGTCTACGCCATTGCCAGGTGCTGCCTGCTACCCCAGGCCAACTGCAGCGTCCACACAGCTCCACCAGCTGAG GCCAGCATGGGGACCCGTGTCCACTGCCACCAACAGGGCCACGTCCTCACAGGCTGCAGCTCCCACTGGGAG GTGGAGGACCTTGGCACCCACAAGCCGCCTGTGCTGAGGCCACGAGGTCAGCCCAACCAGTGCGTGGGCCAC AGGGAGGCCAGCATCCACGCTTCCTGCTGCCATGCCCCAGGTCTGGAATGCAAAGTCAAGGAGCATGGAA Q619P CAG to CCG E620G GAG to GGG TCCCGGCCCCTCAGGAGCAGGTGACCGTGGCCTGCGAGGAGGGCTGGACCCTGACTGGCTGCAGTGCCCTCC CTGGGACCTCCCACGTCCTGGGGGCCTACGCCGTAGACAACACGTGTGTAGTCAGGAGCCGGGACGTCAGCA E670G GAG to GGG CTACAGGCAGCACCAGCGAAGAGGCCGTGACAGCCGTTGCCATCTGCTGCCGGAGCCGGCACCTGGCGCAGG CCTCCCAGGAGCTCCAGTGAC	
h		*ATGGGCACCGTCAGCTCCAGGCGGTCCTGGTGGCCGCTGCCACTGCTGCTGCTGCTGCTGCTCCTGGGTC* R46L CGT to CTT *CCGCGGGCGCCCGTGCG*CAGGAGGACGAGGACGGCGACTACGAGGAGCTGGTGCTAGCCTTGCGTTCCG	35

		A53V GCC to GTC AGGAGGACGGCCTGGCCGAAGCACCCGAGCACGGAACCACAGCCACCTTCCACCGCTGCGCCAAGGAT CCGTGGAGGTTGCCTGGCACCTACGTGGTGGTGCTGAAGGAGGAGACCCACCTCTCGCAGTCAGAGCG CACTGCCCGCCGCCTGCAGGCCCAGGCTGCCCGCCGGGGATACCTCACCAAGATCCTGCATGTCTTCC ATGGCCTTCTTCCTGGCTTCCTGGTGAAGATGAGTGGCGACCTGCTGGAGCTGGCCTTGAAGTTGCCC CATGTCGACTACATCGAGGAGGACTCCTCTGTCTTTGCCCAGagcatcccgtggaacctggagcggattacccctcca cggtaccgggcggatgaataccagccccccgacggaggcagcctggtggaggtgtatctcctagacaccagcatacagagtgaccaccgggaa atcgagggcagggtcatggtcaccgacttcgagaatgtgcccgaggaggacgggacccgcttccacagacaggccagcaagtgtgacagtcat ggcacccacctggcaggggtggtcagcggcccgggatgccggcgtggccaagggtgccagcatgcgcagcctgcgcgtgctcaactgccaaggg aagggcacggttagcggcaccctcataggcctggagtttattcggaaaagccagctggtccagcctgtggggccactggtggtgctgctgcccct ggcgggtgggtacagccgcgtcctcaacgccgcctgccagcgcctggcgagggctggggtcgtgctggtcaccgctgccggcaacttccgggac gatgcctgcctctactccccagcctcagctcccgaggtcatcacagttggggccaccaatgcccaagaccagccggtgaccctggggactttggg gaccaactttggccgctgtgtggacctctttgccccaggggaggacatcattggtgcctccagcgactgcagcacctgctttgtgtcacagagtgg gacatcacaggctgctgcccacgtggctggcattgcagccatgatgctgtctgccgagccggagctcaccctggccgagttgaggcagagactg N425S AAT to AGT A443T GCC to ACC atccacttctctgccaaagatgtcatcaatgaggcctggttccctgaggaccagcgggtactgacccccaacctggtggccacccctgcccccccag cacccatGGGGCAGGTTGGCAGCTGTTTTGCAGGACTGTATGGTCAGCACACTCGGGGCCTACACGGATGGCC I474V ATC to GTC ACAGCCATCGCCCGCTGCGCCCCAGATGAGGAGCTGCTGAGCTGCTCCAGTTTCTCCAGGAGTGGGAAGCGG CGGGGCGAGCGCATGGAGGCCCAAGGGGGCAAGCTGGTCTGCCGGGCCCACAACGCTTTTGGGGGTGAGGG TGTCTACGCCATTGCCAGGTGCTGCCTGCTACCCCAGGCCAACTGCAGCGTCCACACAGCTCCACCAGCTGAG GCCAGCATGGGGACCCGTGTCCACTGCCACCAACAGGGCCACGTCCTCACAGGCTGCAGCTCCCACTGGGAG GTGGAGGACCTTGGCACCCACAAGCCGCCTGTGCTGAGGCCACGAGGTCAGCCCAACCAGTGCGTGGGCCAC AGGGAGGCCAGCATCCACGCTTCCTGCTGCCATGCCCCAGGTCTGGAATGCAAAGTCAAGGAGCATGGAA Q619P CAG to CCG E620G GAG to GGG TCCCGGCCCCTCCGGAGCAGGTGACCGTGGCCTGCGAGGAGGGCTGGACCCTGACTGGCTGCAGTGCCCTCC CTGGGACCTCCCACGTCCTGGGGGCCTACGCCGTAGACAACACGTGTGTAGTCAGGAGCCGGGACGTCAGCA E670G GAG to GGG CTACAGGCAGCACCAGCGAAGAGGCCGTGACAGCCGTTGCCATCTGCTGCCGGAGCCGGCACCTGGCGCAGG CCTCCCAGGAGCTCCAGTGAC	
aj		*ATGGGCACCGTCAGCTCCAGGCGGTCCTGGTGGCCGCTGCCACTGCTGCTGCTGCTGCTGCTCCTGGGTC* R46L CGT to CTT *CCGCGGGCGCCCGTGCG*CAGGAGGACGAGGACGGCGACTACGAGGAGCTGGTGCTAGCCTTGCTTTCCG A53V GCC to GTC AGGAGGACGGCCTGGCCGAAGCACCCGAGCACGGAACCACAGCCACCTTCCACCGCTGCGCCAAGGAT	36

		CCGTGGAGGTTGCCTGGCACCTACGTGGTGGTGCTGAAGGAGGAGACCCACCTCTCGCAGTCAGAGCG CACTGCCCGCCGCCTGCAGGCCCAGGCTGCCCGCCGGGGATACCTCACCAAGATCCTGCATGTCTTCC ATGGCCTTCTTCCTGGCTTCCTGGTGAAGATGAGTGGCGACCTGCTGGAGCTGGCCTTGAAGTTGCCC CATGTCGACTACATCGAGGAGGACTCCTCTGTCTTTGCCCAGagcatcccgtggaacctggagcggattacccctcca cggtaccgggcggatgaataccagccccccgacggaggcagcctggtggaggtgtatctcctagacaccagcatacagagtgaccaccgggaa atcgagggcagggtcatggtcaccgacttcgagaatgtgcccgaggaggacgggacccgcttccacagacaggccagcaagtgtgacagtcat ggcacccacctggcaggggtggtcagcggcccgggatgccggcgtggccaagggtgccagcatgcgcagcctgcgcgtgctcaactgccaaggg aagggcacggttagcggcaccctcataggcctggagtttattcggaaaagccagctggtccagcctgtggggccactggtggtgctgctgcccct ggcgggtgggtacagccgcgtcctcaacgccgcctgccagcgcctggcgagggctggggtcgtgctggtcaccgctgccggcaacttccgggac gatgcctgcctctactccccagcctcagctcccgaggtcatcacagttggggccaccaatgcccaagaccagccggtgaccctggggactttggg gaccaactttggccgctgtgtggacctctttgccccaggggaggacatcattggtgcctccagcgactgcagcacctgctttgtgtcacagagtgg gacatcacaggctgctgcccacgtggctggcattgcagccatgatgctgtctgccgagccggagctcaccctggccgagttgaggcagagactg N425S AAT to AGT A443T GCC to ACC atccacttctctgccaaagatgtcatcaatgaggcctggttccctgaggaccagcgggtactgacccccaacctggtggccgccctgccccccag cacccatGGGGCAGGTTGGCAGCTGTTTTGCAGGACTGTATGGTCAGCACACTCGGGGCCTACACGGATGGCC I474V ATC to GTC ACAGCCGTCGCCCGCTGCGCCCCAGATGAGGAGCTGCTGAGCTGCTCCAGTTTCTCCAGGAGTGGGAAGCGG CGGGGCGAGCGCATGGAGGCCCAAGGGGGCAAGCTGGTCTGCCGGGCCCACAACGCTTTTGGGGGTGAGGG TGTCTACGCCATTGCCAGGTGCTGCCTGCTACCCCAGGCCAACTGCAGCGTCCACACAGCTCCACCAGCTGAG GCCAGCATGGGGACCCGTGTCCACTGCCACCAACAGGGCCACGTCCTCACAGGCTGCAGCTCCCACTGGGAG GTGGAGGACCTTGGCACCCACAAGCCGCCTGTGCTGAGGCCACGAGGTCAGCCCAACCAGTGCGTGGGCCAC AGGGAGGCCAGCATCCACGCTTCCTGCTGCCATGCCCCAGGTCTGGAATGCAAAGTCAAGGAGCATGGAA Q619P CAG to CCG E620G GAG to GGG TCCCGGCCCCTCAGGAGCAGGTGACCGTGGCCTGCGAGGAGGGCTGGACCCTGACTGGCTGCAGTGCCCTCC CTGGGACCTCCCACGTCCTGGGGGCCTACGCCGTAGACAACACGTGTGTAGTCAGGAGCCGGGACGTCAGCA E670G GAG to GGG CTACAGGCAGCACCAGCGAAGAGGCCGTGACAGCCGTTGCCATCTGCTGCCGGAGCCGGCACCTGGCGCAGG CCTCCCAGGAGCTCCAGTGAC	
q		*ATGGGCACCGTCAGCTCCAGGCGGTCCTGGTGGCCGCTGCCACTGCTGCTGCTGCTGCTGCTCCTGGGTC* R46L CGT to CTT *CCGCGGGCGCCCGTGCG*CAGGAGGACGAGGACGGCGACTACGAGGAGCTGGTGCTAGCCTTGCGTTCCG A53V GCC to GTC AGGAGGACGGCCTGGTCGAAGCACCCGAGCACGGAACCACAGCCACCTTCCACCGCTGCGCCAAGGAT CCGTGGAGGTTGCCTGGCACCTACGTGGTGGTGCTGAAGGAGGAGACCCACCTCTCGCAGTCAGAGCG CACTGCCCGCCGCCTGCAGGCCCAGGCTGCCCGCCGGGGATACCTCACCAAGATCCTGCATGTCTTCC	37

		ATGGCCTTCTTCCTGGCTTCCTGGTGAAGATGAGTGGCGACCTGCTGGAGCTGGCCTTGAAGTTGCCC CATGTCGACTACATCGAGGAGGACTCCTCTGTCTTTGCCCAGagcatcccgtggaacctggagcggattacccctcca cggtaccgggcggatgaataccagcccccgacggaggcagcctggtggaggtgtatctcctagacaccagcatacagagtgaccaccgggaa atcgagggcagggtcatggtcaccgacttcgagaatgtgcccgaggaggacgggacccgcttccacagacaggccagcaagtgtgacagtcat ggcacccacctggcaggggtggtcagcggccgggatgccggcgtggccaagggtgccagcatgcgcagcctgcgcgtgctcaactgccaaggg aagggcacggttagcggcaccctcataggcctggagtttattcggaaaagccagctggtccagcctgtggggccactggtggtgctgctgcccct ggcgggtgggtacagccgcgtcctcaacgccgcctgccagcgcctggcgagggctggggtcgtgctggtcaccgctgccggcaacttccgggac gatgcctgcctctactccccagcctcagctcccgaggtcatcacagttggggccaccaatgcccaagaccagccggtgaccctggggactttggg gaccaactttggccgctgtgtggacctctttgccccaggggaggacatcattggtgcctccagcgactgcagcacctgctttgtgtcacagagtgg gacatcacaggctgctgcccacgtggctggcattgcagccatgatgctgtctgccgagccggagctcaccctggccgagttgaggcagagactg N425S AAT to AGT A443T GCC to ACC atccacttctctgccaaagatgtcatcaatgaggcctggttccctgaggaccagcgggtactgacccccaacctggtggccgccctgccccccag cacccatGGGGCAGGTTGGCAGCTGTTTTGCAGGACTGTATGGTCAGCACACTCGGGGCCTACACGGATGGCC I474V ATC to GTC ACAGCCATCGCCCGCTGCGCCCCAGATGAGGAGCTGCTGAGCTGCTCCAGTTTCTCCAGGAGTGGGAAGCGG CGGGGCGAGCGCATGGAGGCCCAAGGGGGCAAGCTGGTCTGCCGGGCCCACAACGCTTTTGGGGGTGAGGG TGTCTACGCCATTGCCAGGTGCTGCCTGCTACCCCAGGCCAACTGCAGCGTCCACACAGCTCCACCAGCTGAG GCCAGCATGGGGACCCGTGTCCACTGCCACCAACAGGGCCACGTCCTCACAGGCTGCAGCTCCCACTGGGAG GTGGAGGACCTTGGCACCCACAAGCCGCCTGTGCTGAGGCCACGAGGTCAGCCCAACCAGTGCGTGGGCCAC AGGGAGGCCAGCATCCACGCTTCCTGCTGCCATGCCCCAGGTCTGGAATGCAAAGTCAAGGAGCATGGAA Q619P CAG to CCG E620G GAG to GGG TCCCGGCCCCTCAGGAGCAGGTGACCGTGGCCTGGAGGAGGGCTGGACCCTGACTGGCTGCAGTGCCCTCC CTGGGACCTCCCACGTCCTGGGGGCCTACGCCGTAGACAACACGTGTGTAGTCAGGAGCCGGGACGTCAGCA E670G GAG to GGG CTACAGGCAGCACCAGCGAAGGGGCCGTGACAGCCGTTGCCATCTGCTGCCGGAGCCGGCACCTGGCGCAGG CCTCCCAGGAGCTCCAGTGAC	

[0716] Reference to sequence positions throughout this specification are to the sequence positions as identified in the description and tables. For example, position 474 of SEQ ID NO:1 is the position identified in SEQ ID NO:1 in Table 5.

Table 6: Human VH3-23 Variant Alleles

VH3-23 haplotype	Cumulative allele frequency	SNPs			
a (=VH3-23*04)	0.0983	rs56069819			
d	0.0087	rs56069819	rs61750837	rs61752504	
e	0.0046	rs56069819	rs1064090	rs1055799	
j	0.0009	rs56069819	rs1055799		
u	0.0005	rs56069819	rs1064091		
s	0.0005	rs56069819	rs1064091	rs61752504	rs61750837
r	0.0005	rs56069819	rs1064090		
TOTAL:	**0.114**				

Table 7: Exemplary anti-PCSK9 antibodies and/or antibody fragments useful in any and all aspects of the invention

SEQ ID NOs comprising an anti-PCSK9 monoclonal antibody or fragment thereof which are incorporated by reference from the patent application publication numbers recited in the abutting column.	**Patent or patent Publication which is incorporated by reference in its entirety, and specifically with respect to the SEQ ID Nos. comprising an anti-PCSK9 monoclonal antibody or fragment thereof cited in the abutting column.**
Light chain complementary determining regions (CDRL) SEQ ID NO: 5, 7, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42, 44, 46, 270, 271, 272, 273, 275, 277, 286, 287, 288, 297, 299, 301, 405, 407, 409, 411, 413, 415, 417, 421, 425, 429, 433, 437, 441, 445, 449, 453, 457, 461, 465, 469, 473, 477, 481, 485;	US20120020975 A1

(continued)

SEQ ID NOs comprising an anti-PCSK9 monoclonal antibody or fragment thereof which are incorporated by reference from the patent application publication numbers recited in the abutting column.	Patent or patent Publication which is incorporated by reference in its entirety, and specifically with respect to the SEQ ID Nos. comprising an anti-PCSK9 monoclonal antibody or fragment thereof cited in the abutting column.
Heavy chain complementary determining regions (CDRH) SEQ ID NO: 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 60, 61, 62, 64, 65, 67, 69, 71, 72, 74, 76, 77, 78, 79, 80, 81, 83, 85, 87, 89, 91, 278, 289, 290, 291, 292, 298, 300, 302, 401, 404, 406, 408, 410, 412, 414, 416, 419, 423, 427, 431, 435, 439, 443, 447, 451, 455, 459, 463, 467, 471, 475, 479, 483;	
CDRL SEQ ID NO: 5, 7, 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42, 44, 46, 405, 407, 409, 411, 413, 415, 417, 465; CDRH SEQ ID NO: 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 60, 62, 64, 65, 67, 69, 71, 72, 74, 76, 77, 78, 79, 80, 81, 83, 85, 87, 89, 91, 404, 406, 408, 410, 412, 414, 416, 463;	US20120027765A1
CDRL SEQ ID NO: 5, 7, 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42, 44, 46, 405, 407, 409, 411, 413, 415, 417, 465; CDRH SEQ ID NO: 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 60, 62, 64, 65, 67, 69, 71, 72, 74, 76, 77, 78, 79, 80, 81, 83, 85, 87, 89, 91, 404, 406, 408, 410, 412, 414, 416, 463;	US8168762B2
CDRL SEQ ID NO: 5, 7, 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42, 44, 46, 222, 229, 238, 405, 407, 409, 411, 413, 415, 417; CDRH SEQ ID NO: 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 60, 62, 64, 65, 67, 69, 71, 72, 74, 76, 77, 78, 79, 80, 81, 83, 85, 87, 89, 91, 247, 256, 265, 404, 406, 408, 410, 412, 414, 416;	US20120020976A1
CDRL SEQ ID NO: 5, 7, 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42, 44, 46, 405, 407, 409, 411, 413, 415, 417, 461, 465, 485; CDRH SEQ ID NO: 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 60, 62, 64, 65, 67, 69, 71, 72, 74, 76, 77, 78, 79, 80, 81, 83, 85, 87, 89, 91, 404, 406, 408, 410, 412, 414, 416, 459, 463, 483;	US20130085265A1
CDRL SEQ ID NO: 5, 7, 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42, 44, 46, 405, 407, 409, 411, 413, 415, 417, 461, 465, 485; CDRH SEQ ID NO: 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 60, 62, 64, 65, 67, 69, 71, 72, 74, 76, 77, 78, 79, 80, 81, 83, 85, 87, 89, 91, 404, 406, 408, 410, 412, 414, 416, 459, 463, 483;	US20130079501A1
CDRL SEQ ID NO: 5, 7, 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42, 44, 46, 405, 407, 409, 411, 413, 415, 417, 158, 162, 395, 473, 477;	US20120213797A1

(continued)

SEQ ID NOs comprising an anti-PCSK9 monoclonal antibody or fragment thereof which are incorporated by reference from the patent application publication numbers recited in the abutting column.	Patent or patent Publication which is incorporated by reference in its entirety, and specifically with respect to the SEQ ID Nos. comprising an anti-PCSK9 monoclonal antibody or fragment thereof cited in the abutting column.
CDRH SEQ ID NO: 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 60, 62, 64, 65, 67, 69, 71, 72, 74, 76, 77, 78, 79, 80, 81, 83, 85, 87, 89, 91, 404, 406, 408, 410, 412, 414, 416, 180, 175, 308, 368, 471, 475;	
CDRL SEQ ID NO: 5, 7, 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42, 44, 46, 405, 407, 409, 411, 413, 415, 417; CDRH SEQ ID NO: 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 60, 62, 64, 65, 67, 69, 71, 72, 74, 76, 77, 78, 79, 80, 81, 83, 85, 87, 89, 91, 404, 406, 408, 410, 412, 414, 416;	US20120251544A1
CDRL SEQ ID NO: 5, 7, 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42, 44, 46, 405, 407, 409, 411, 413, 415, 417, 461, 465, 485; CDRH SEQ ID NO: 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 60, 62, 64, 65, 67, 69, 71, 72, 74, 76, 77, 78, 79, 80, 81, 83, 85, 87, 89, 91, 404, 406, 408, 410, 412, 414, 416, 459, 463, 483;	US20130052201A1
CDRL SEQ ID NO: 5, 7, 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42, 44, 46, 405, 407, 409, 411, 413, 415, 417, 461, 465, 485; CDRH SEQ ID NO: 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 60, 62, 64, 65, 67, 69, 71, 72, 74, 76, 77, 78, 79, 80, 81, 83, 85, 87, 89, 91, 404, 406, 408, 410, 412, 414, 416, 459, 463, 483;	US20130058944A1
CDRL SEQ ID NO: 5, 7, 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42, 44, 46, 405, 407, 409, 411, 413, 415, 417; CDRH SEQ ID NO: 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 60, 62, 64, 65, 67 69, 71, 72, 74, 76, 77, 78, 79, 80, 81, 83, 85, 87, 89, 91, 404, 406, 408, 410, 412, 414, 416;	US20130079502A1
CDRL SEQ ID NO: 5, 7, 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 42, 44, 46, 405, 407, 409, 411, 413, 415, 417; CDRH SEQ ID NO: 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 60, 62, 64, 65, 67, 69, 71, 72, 74, 76, 77, 78, 79, 80, 81, 83, 85, 87, 89, 91, 404, 406, 408, 410, 412, 414, 416;	US20130245235A1

Table 8: Human variable & constant variants distributed over several human ethnic populations - useful for ligand tailoring

Human Gene Segment Type	Example Human Allele[1]	Amino Acid Position & Variation	Nucleotide Variation[2] (NCBI dbSNP reference number)[3]	Variant Nucleotide Position	Human Populations[4]	No. Individs[5]	Het Freq[6]	Hom Freq[7] (Het + Hom freq[8])	Cum Freq[9]
IGHG1	IGHG1*01	204D (CH3 variation)	GAT	14: 106208086 (forward strand)	A (European ancestry)	153	0.400	0.096 (0.496)	0.296
	IGHG1*03	204E (CH3 variation)	GAG (rs1045853)	14: 106208086 (forward strand)	A (European ancestry	366	0.400	0.504 (0.904)	0.704
	IGHG1*01	206L (CH3 variation)	CTG	14: 106208082 (forward strand)	A (European ancestry)		0.358	0.104 (0.462)	0.283
	IGHG1*03	206M (CH3 variation)	ATG (rs11621259)	14: 106208082 (forward strand)	A (European ancestry)		0.358	0.538 (0.896)	0.717

(continued)

Human Gene Segment Type	Example Human Allele[1]	Amino Acid Position & Variation	Nucleotide Variation[2] (NCBI dbSNP reference number)[3]	Variant Nucleotide Position	Human Populations[4]	No. Individs[5]	Het Freq[6]	Hom Freq[7] (Het + Hom freq[8])	Cum Freq[9]
IGHG2	IGHG2*01	72P (CH1 variation)	CCC	14: 106110914 (forward strand)	B		0.336	0.540 (0.876)	0.708
	IGHG2*02	72T (CH1 variation)	ACC (rs11627594)	14: 106110914 (forward strand)	B		0.336	0.124	0.292
	IGHG2*01	75N (CH1 variation)	AAC	14: 106110904 (forward strand)	A		0.007	0.993	0.997
	IGHG2*04	75S (CH1 variation)	AGC (rs201590297)	14: 106110904 (forward strand)	A		0.007		0.004
	IGHG2*01	76F (CH1 variation)	TTC						
	IGHG2*04	76L (CH1 variation)	TTG						
	IGHG2*01	161V (CH2 variation)	GTG	14:10611013 (forward strand)	B		0.342	0.539 (0.881)	0.711
	IGHG2*02	161M (CH2 variation)	ATG (rs8009156)	14:10611013 (forward strand)	B		0.342	0.118 (0.46)	0.289

(continued)

Human Gene Segment Type	Example Human Allele[1]	Amino Acid Position & Variation	Nucleotide Variation[2] (NCBI dbSNP reference number)[3]	Variant Nucleotide Position	Human Populations[4]	No. Individs[5]	Het Freq[6]	Hom Freq[7] (Het + Hom freq[8])	Cum Freq[9]
	IGHG2*01	257A (CH3 variation)	GCC	14: 106109752 (forward strand)	C D		0.199 0.007	0.493 (0.692) 0.992 (0.999)	0.592 0.995
	IGHG2*06	257S (CH3 variation)	TCC (rs4983499)	14: 106109752 (forward strand)	C D		0.199 0.007	0.308 (0.507) 0.002 (0.009)	0.408 0.005

Table Footnotes:
1. IMGT notation (ww.imgt.org); refer to figures for other alleles comprising this variation.
2. SNP Underlined in Codon.
3. NCBI dbSNP Build 138 released on Apr 25, 2013.
4. Human population used for representative variant frequency analysis.

Populations

[0717]

A This population included 662 participants of European descent from the ClinSeq project, all of whom had undergone whole-exome sequencing using Agilent's 38Mb or 50Mb capture kit.
B 1000 Genomes database.
C ESP6500:African_American.
D ESP6500:European_American.

5. Number of individuals in representative population found to have the allele.
6. Heterozygous human genotype frequency, ie, cumulative frequency of all genotypes having one occurrence of the variant allele and one occurrence of another allele (heterozygous state), eg, acgenotype in the population.
7. Homozygous human genotype frequency, ie, cumulative frequency of two occurrences of the variant allele (homozygous state), eg, ccgenotype in the population.
8. Total human genotype frequency, ie, total of heterozygous plus homozygous human genotype frequencies.
9. Cumulative human allele frequency of all occurrences of the variant allele in the population.

Table 9: FURTHER SEQUENCES

SEQ ID NO	Human Allele	Nucleotide/ Amino Acid Sequence
HEAVY CHAIN ALLELES		
41	IGHG1*01 (CH1+Hinge+CH2+CH3+CH-S)	gcctccaccaagggcccatcggtcttccccctggcaccctcctccaagagcacctctggg ggcacagcggccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcg tggaactcaggcgccctgaccagcggcgtgcacaccttcccggctgtcctacagtcctca ggactctactccctcagcagcgtggtgaccgtgccctccagcagcttgggcacccagacc tacatctgcaacgtgaatcacaagcccagcaacaccaaggtggacaagaaagttgagccc aaatcttgtgacaaaactcacacatgcccaccgtgcccagcacctgaactcctgggggga ccgtcagtcttcctcttccccccaaaacccaaggacaccctcatgatctcccggacccct gaggtcacatgcgtggtggtggacgtgagccacgaagaccctgaggtcaagttcaactgg tacgtggacggcgtggaggtgcataatgccaagacaaagccgcgggaggagcagtacaac agcacgtaccgggtggtcagcgtcctcaccgtcctgcaccaggactggctgaatggcaag gagtacaagtgcaaggtctccaacaaagccctcccagcccccatcgagaaaaccatctcc aaagccaaagggcagccccgagaaccacaggtgtacaccctgcccccatcccgggatgag ctgaccaagaaccaggtcagcctgacctgcctggtcaaaggcttctatcccagcgacatc gccgtggagtgggagagcaatgggcagccggagaacaactacaagaccacgcctcccgtg ctggactccgacggctccttcttcctctacagcaagctcaccgtggacaagagcaggtgg cagcaggggaacgtcttctcatgctccgtgatgcatgaggctctgcacaaccactacacg cagaagagcctctccctgtctccgggtaaa
42		ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHT FPAVLQSS GLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSCDKTHTCPPCP APELLGG PSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYVDGVEVHNAKT KPREEQYN STYRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTISKAKGQPREPQVY TLPPSR**D**E **L**TKNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTPPVLDSDGSFFLYSK LTVDKSRW QQGNVFSCSVMHEALHNHYTQKSLSLSPGK **D**=position 204 **L**=position 206
43	IGHG2*01 (CH1+Hinge+CH2+CH3+CH-S)	gcctccaccaagggcccatcggtcttccccctggcgccctgctccaggagcacctccgag agcacagccgccctgggctgcctggtcaaggactacttccccgaaccggtgacggtgtcg tggaactcaggcgctctgaccagcggcgtgcacaccttcccagctgtcctacagtcctca ggactctactccctcagcagcgtggtgaccgtgccctccagcaacttcggcacccagacc tacacctgcaacgtagatcacaagcccagcaacaccaaggtggacaagacagttgagcgc aaatgttgtgtcgagtgcccaccgtgcccagcaccacctgtggcaggaccgtcagtcttc ctcttccccccaaaacccaaggacaccctcatgatctcccggacccctgaggtcacgtgc gtggtggtggacgtgagccacgaagaccccgaggtccagttcaactggtacgtggacggc gtggaggtgcataatgccaagacaaagccacgggaggagcagttcaacagcacgttccgt gtggtcagcgtcctcaccgttgtgcaccaggactggctgaacggcaaggagtacaagtgc aaggtctccaacaaaggcctcccagcccccatcgagaaaaccatctccaaaaccaaaggg cagccccgagaaccacaggtgtacaccctgcccccatcccgggaggagatgaccaagaac caggtcagcctgacctgcctggtcaaaggcttctaccccagcgacatcgccgtggagtgg

(continued)

SEQ ID NO	Human Allele	Nucleotide/ Amino Acid Sequence
HEAVY CHAIN ALLELES		
		gagagcaatgggcagccggagaacaactacaagaccacacctcccatgctggactccgac ggctccttcttcctctacagcaagctcaccgtggacaagagcaggtggcagcaggggaac gtcttctcatgctccgtgatgcatgaggctctgcacaaccactacacgcagaagagcctc tccctgtctccgggtaaa
44		ASTKGPSVFPLAPCSRSTSESTAALGCLVKDYFPEPVTVSWNSGALTSGVHTF PAVLQSS GLYSLSSVVTV**P**SS**NF**GTQTYTCNVDHKPSNTKVDKTVERKCCVECPPCPAP PVAGPSVF LFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVQFNWYVDG**V**EVHNAKTKPR EEQFNSTFR VVSVLTVVHQDWLNGKEYKCKVSNKGLPAPIEKTISKTKGQPREPQVYTLPP SREEMTKN QVSLTCLVKGFYPSDI**A**VEWESNGQPENNYKTTPPMLDSDGSFFLYSKLTVD KSRWQQGN VFSCSVMHEALHNHYTQKSLSLSPGK **P**=position 72 **N**=position 75 **F**=position 76 **V**=position 161 **A**=position 257
45	IGHV1-18*01	caggttcagctggtgcagtctggagctgaggtgaagaagcctggggcctcagtgaaggtc tcctgcaaggcttctggttacacctttaccagctatggtatcagctgggtgcgacaggcc cctggacaagggcttgagtggatgggatggatcagcgcttacaatggtaacacaaactat gcacagaagctccagggcagagtcaccatgaccacagacacatccacgagcacagcctac atggagctgaggagcctgagatctgacgacacggccgtgtattactgtgcgagaga
46		QVQLVQSGAEVKKPGASVKVSCKASGYTFTSYGISWVRQAP GQGLEWMGWISAYNGNTNYAQKLQGRVTMTTDTSTSTAYMELRSLRSDD TAVYYCAR
47	IGHV1-46*01	caggtgcagctggtgcagtctggggctgaggtgaagaagcctggggcctcagtgaaggtt tcctgcaaggcatctggatacaccttcaccagctactatatgcactgggtgcgacaggcc cctggacaagggcttgagtggatgggaataatcaaccctagtggtggtagcacaagctac gcacagaagttccagggcagagtcaccatgaccagggacacgtccacgagcacagtctac atggagctgagcagcctgagatctgaggacacggccgtgtattactgtgcgagaga
48		QVQLVQSGAEVKKPGASVKVSCKASGYTFTSYYMHWVRQAP GQGLEWMGIINPSGGSTSYAQKFQGRVTMTRDTSTSTVYMELSSLRSEDTA VYYCAR
LIGHT CHAIN ALLELES		

(continued)

SEQ ID NO	Human Allele	Nucleotide/ Amino Acid Sequence
HEAVY CHAIN ALLELES		
49	IGKC*01	cgaactgtggctgcaccatctgtcttcatcttcccgccatctgatgagcagttgaaatct ggaactgcctctgttgtgtgcctgctgaataacttctatcccagagaggccaaagtacag tggaaggtggataacgccctccaatcgggtaactcccaggagagtgtcacagagcaggac agcaaggacagcacctacagcctcagcagcaccctgacgctgagcaaagcagactacgag aaacacaaagtctacgcctgcgaagtcacccatcagggcctgagctcgcccgtcacaaag agcttcaacaggggagagtgt
50		RTVAAPSVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNS QESVTEQD SKDSTYSLSSTLTLSKADYEKHK**V**YA**C**EVTHQGLSSPVTKSFNRGEC
		V=position 84 **C**=position 87
51	IGLC2*01	ggtcagcccaaggctgccccctcggtcactctgttcccgccctcctctgaggagcttcaa gccaacaaggccacactggtgtgtctcataagtgacttctacccgggagccgtgacagtg gcttggaaagcagatagcagccccgtcaaggcgggagtggagaccaccacaccctccaaa caaagcaacaacaagtacgcggccagcagctatctgagcctgacgcctgagcagtggaag tcccacagaagctacagctgccaggtcacgcatgaagggagcaccgtggagaagacagtg gcccctacagaatgttca
52		GQPKAAPSVTLFPPSSEELQANKATLVCLISDFYPGAVTVAWKADSSPVKAG VETTTPSK QSNNKYAASSYLSLTPEQWKSHRSYSCQVTHEGSTVEKTVAPTECS
53	IGKV4-1*01	atggtgttgcagacccaggtcttcatttctctgttgctctggatctctggtgcctacggg gacatcgtgatgacccagtctccagactccctggctgtgtctctgggcgagagggccacc atcaactgcaagtccagccagagtgttttatacagctccaacaataagaactacttagct tggtaccagcagaaaccaggacagcctcctaagctgctcatttactgggcatctacccgg gaatccggggtccctgaccgattcagtggcagcgggtctgggacagatttcactctcacc atcagcagcctgcaggctgaagatgtggcagtttattactgtcagcaatattatagtact cctcc
54		DIVMTQSPDSLAVSLGERATINCKSSQSVLYSSNNKNYLA WYQQKPGQPPKLLIYWASTRESGVPDRFSGSGSGTDFTLTISSLQAEDVAVY YCQQYYST P

(continued)

SEQ ID NO	Human Allele	Nucleotide/ Amino Acid Sequence
HEAVY CHAIN ALLELES		
55	IGKV1-13*02	atggacatgagggtccccgctcagctcctggggcttctgctgctctggctcccagcaggt gccagatgtgccatccagttgacccagtctccatcctccctgtctgcatctgtaggagac agagtcaccatcacttgccgggcaagtcagggcattagcagtgctttagcctggtatcag cagaaaccagggaaagctcctaagctcctgatctatgatgcctccagtttggaaagtggg gtcccatcaaggttcagcggcagtggatctgggacagatttcactctcaccatcagcagc ctgcagcctgaagattttgcaacttattactgtcaacagtttaatagttaccctcagtgc cagatgtgccatccagttgacccagtctccatcctccctgtctgcatctgtaggagacag agtcaccatcacttgccgggcaagtcagggcattagcagtgctttagcctggtatcagca gaaaccagggaaagctcctaagctcctgatctatgatgcctccagtttggaaagtggggt cccatcaaggttcagcggcagtggatctgggacagatttcactctcaccatcagcagcct gcagcctgaagattttgcaacttattactgtcaacagtttaatagttaccctca
57	IGKJ2*01	tgtacacttttggccaggggaccaagctggagatcaaac
58		YTFGQGTKLEIK
59	IGU2*01	tgtggtattcggcggagggaccaagctgaccgtcctag
60		WFGGGTKLTVL
61	An IGHG1*01 Heavy Chain Constant Region	ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHT FPAVLQSSGLYSLSSVVTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSCDK THTCPPCPAPELLGGPS VFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVKFNWYVDGVEVHNAKTKP REEQYNST YRVVSVLTVLHQDWLNGKEYKCKVSNKALPAPIEKTISKAKGQPREPQVYTL PPSRDELT KNQVSLTCLVKGFYPSDIAVEWESNGQPENNYKTTPPVLDSDGSFFLYSKLT VDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPG
62	An IGKC*01 Kappa Light Chain Constant Region	RTVAAPSVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNS QESVTEQDSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNR GEC
63	An IGHG2*01 Heavy Chain Constant Region	ASTKGPSVFPLAPCSRSTSESTAALGCLVKDYFPEPVTVSWNSGALTSGVHTF PAVLQSSGLYSLSSVVTVPSSNFGTQTYTCNVDHKPSNTKVDKTVERKCCVE CPPCPAPPVAGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVQFNWY VDGVEVHNAKTKPREEQFNSTFRVVSVLTVVHQDWLNGKEYKCKVSNKGLP APIEKTISKTKGQPREPQVYTLPPSREEMTKNQVSLTCLVKGFYPSDIAVEWE SNGQPENNYKTTPPMLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEAL HNHYTQKSLSLSPGK
64	An IGLC2*01 Lambda Light Chain Constant Region	QPKAAPSVTLFPPSSEELQANKATLVCLISDFYPGAVTVAWKADSSPVKAGVE TTTPSKQSNNKYAASSYLSLTPEQWKSHRSYSCQVTHEGSTVEKTVAPTECS

(continued)

SEQ ID NO	Human Allele	Nucleotide/ Amino Acid Sequence
HEAVY CHAIN ALLELES		
65	An IGHG2*01 Heavy Chain Constant Region	ASTKGPSVFPLAPCSRSTSESTAALGCLVKDYFPEPVTVSWNSGALTSGVHTF PAVLQSSGLYSLSSVVTVPSSNFGTQTYTCNVDHKPSNTKVDKTVERKCCVE CPPCPAPPVAGPSVFLFPPKPKDTLMISRTPEVTCVVVDVSHEDPEVQFNWY VDGVEVHNAKTKPREEQFNSTFRVVSVLTVVHQDWLNGKEYKCKVSNKGLP SSIEKTISKTKGQPREPQVYTLPPSREEMTKNQVSLTCLVKGFYPSDIAVEWE SNGQPENNYKTTPPMLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEAL HNHYTQKSLSLSPGK
66	An IGKC*01 Kappa Light Chain Constant Region	RTVAAPSVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNS QESVTEQDSKDSTYSLSSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNR GEC

STATEMENTS OF INVENTION:

[0718]

A. A method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, the method comprising administering to said human an antibody or antibody fragment that specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 or E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human gamma-1 heavy chain constant region that comprises an Asp corresponding to position 204 of SEQ ID NO: 42 or a Leu corresponding to position 206 of SEQ ID NO: 42 and wherein said human comprises (i) an IGHG1*01 human heavy chain constant region gene segment, or the human expresses antibodies comprising an Asp corresponding to position 204 of SEQ ID NO: 42 and Leu corresponding to position 206 of SEQ ID NO: 42 and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1.

B. The method of statement A, wherein the antibody or fragment comprises a human gamma-1 heavy chain constant region that comprises an Asp corresponding to position 204 of SEQ ID NO: 42 and a Leu corresponding to position 206 of SEQ ID NO: 42.

C. The method of statement A, wherein said antibody or antibody fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474 or E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human gamma-1 heavy chain constant region that comprises an Asp corresponding to position 204 of SEQ ID NO: 42 and a Leu corresponding to position 206 of SEQ ID NO: 42 and wherein said human comprises (i) an IGHG1*01 human heavy chain constant region gene segment and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation in SEQ ID NO: 1.

D. The method of any preceding statement, wherein the antibody or fragment comprises an IGHG1*01 human heavy chain constant region.

E. The method of any preceding statement, comprising, before said administering, selecting a human comprising said nucleotide sequence of (ii), wherein the human is the human of statement A.

F. The method of any preceding statement, wherein the human has been determined to comprise the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1 and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein encoded by the nucleotide sequence of SEQ ID NO: 29 or 30.

G. The method of any preceding statement, comprising the step of determining that the human comprises the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein comprising said mutation I474V or E670G, optionally, wherein the determining step is performed before administration of the antibody to the human.

H. The method of statement G, wherein the step of determining comprises assaying a biological sample from the human for a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

I. The method of statement H, wherein the assaying comprises contacting the biological sample with

a. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides that can specifically hybridize to and identify in the biological sample a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or that specifically hybridizes to an antisense of said sequence, wherein said nucleic acid hybridizes to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridizes to an antisense sequence thereby forming a complex when at least one nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and/or

b. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides of a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or comprising an antisense sequence of said contiguous nucleotides, wherein said sequence of contiguous nucleotides comprises at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 thereby forming a complex when the nucleotide sequence encoding the PCSK9 that comprises a C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and

detecting the presence or absence of the complex, wherein detecting the presence of the complex determines that the human comprises the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

J. The method of statement H, wherein the assaying comprises nucleic acid amplification and optionally one or more methods selected from sequencing, next generation sequencing, nucleic acid hybridization, and allele-specific amplification and/or wherein the assaying is performed in a multiplex format.

K. The method of any preceding statement, wherein said human is or has been further determined to be substantially resistant to statin treatment.

L. The method of any preceding statement, wherein said human is receiving or has received statin treatment or has reduced responsiveness to statin treatment.

M. The method of any preceding statement, wherein said antibody or antibody fragment is administered to the human separately or simultaneously with said statin treatment.

N. The method of statement H, wherein said biological sample comprises serum, blood, faeces, tissue, a cell, urine and/or saliva of said human.

O. The method of any preceding statement, wherein said human is indicated as heterozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising said mutation I474V or E670G, optionally, wherein said human is further indicated as comprising the nucleotide sequence of SEQ ID NO: 28, or said human is indicated as homozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising said mutation I474Vor E670G in SEQ ID NO: 1.

P. The method of any preceding statement, wherein said human has been diagnosed with at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication (e.g. claudication associated with elevated cholesterol) and high blood pressure.

Q. The method of any preceding statement, wherein said antibody or antibody fragment treats or reduces the risk in said human of at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication (e.g. claudication associated with elevated cholesterol) and high blood pressure.

R. The method of any preceding statement, wherein the nucleotide sequence is SEQ ID NO: 29 or 30.

S. The method of any preceding statement, wherein said antibody or antibody fragment is administered by intravenous or subcutaneous administration and/or is comprised in an injectable preparation.

Statements of Invention

[0719] Statements of invention also include:

1. An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human in need thereof, wherein the antibody or fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474V or E670G in SEQ ID NO: 1 and wherein the antibody or fragment comprises a human gamma-1 heavy chain constant region that comprises an amino acid selected from the group consisting of:
an Asp corresponding to position 204 of SEQ ID NO: 42 and a Leu corresponding to position 206 of SEQ ID NO: 42 and wherein said human comprises

(i) an IGHG1*01 human heavy chain constant region gene segment, or the human expresses antibodies comprising a human gamma-1 heavy chain constant region that comprises said amino acid and
(ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation in SEQ ID NO: 1.

2. The antibody or antibody fragment of statement 1, wherein the antibody or fragment comprises a human gamma-1 heavy chain constant region that comprises an Asp corresponding to position 204 of SEQ ID NO: 42 and a Leu corresponding to position 206 of SEQ ID NO: 42.

3. The antibody or antibody fragment of statement 1, wherein said antibody or antibody fragment specifically binds a proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474V or E670G in SEQ ID NO: 1, wherein the antibody or fragment comprises a human gamma-1 heavy chain constant region that comprises an Asp corresponding to position 204 of SEQ ID NO: 42 and a Leu corresponding to position 206 of SEQ ID NO: 42 and wherein said human comprises (i) an IGHG1*01 human heavy chain constant region gene segment and (ii) a nucleotide sequence encoding said proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising said mutation in SEQ ID NO: 1.

4. The antibody or antibody fragment of any preceding statement, wherein the antibody or fragment comprises an IGHG1*01 human heavy chain constant region.

5. The antibody or antibody fragment of any preceding statement, wherein the method comprises, before administration of said antibody or fragment, selecting a human comprising said nucleotide sequence of (ii), wherein the human is the human of statement 1.

6. The antibody or antibody fragment of any preceding statement, wherein (i) the human has been determined to comprise the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G in SEQ ID NO: 1 and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein encoded by the nucleotide sequence of SEQ ID NO: 29 or 30 or (ii) wherein the method comprises the step of determining that the human comprises the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V or E670G and/or a proprotein convertase subtilisin/kexin type 9 (PCSK9) variant protein comprising said mutation I474V or E670G, optionally, wherein the determining step is performed before administration of the antibody to the human.

7. The antibody or antibody fragment of statement 6, wherein the step of determining comprises assaying a biological sample from the human for a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

8. The antibody or antibody fragment of statement 7, wherein the assaying comprises contacting the biological sample with

a. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides that can specifically hybridize to and identify in the biological sample a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or that specifically hybridizes to an antisense of said sequence, wherein said nucleic acid hybridizes to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridizes to an antisense sequence thereby forming a complex when at least one nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and/or

b. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides of a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 or comprising an antisense sequence of said contiguous nucleotides, wherein said sequence of contiguous nucleotides comprises at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 thereby forming a complex when the nucleotide sequence encoding the PCSK9 that comprises a C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1 is present; and

detecting the presence or absence of the complex, wherein detecting the presence of the complex determines that the human comprises the PCSK9 that comprises the C-terminal domain comprising the mutation I474V or E670G in SEQ ID NO: 1.

9. The antibody or antibody fragment of statement 7, wherein the assaying comprises nucleic acid amplification and optionally one or more methods selected from sequencing, next generation sequencing, nucleic acid hybridization, and allele-specific amplification and/or wherein the assaying is performed in a multiplex format.

10. The antibody or antibody fragment of any preceding statement, wherein the antibody or antibody fragment is for administration to a human that is is or has been further determined to be substantially resistant to statin treatment.

11. The antibody or antibody fragment of any preceding statement, wherein the antibody or antibody fragment is for administration to a human that is receiving or has received statin treatment or has reduced responsiveness to statin treatment.

12. The antibody or antibody fragment of any preceding statement, wherein said antibody or antibody fragment is for administration to the human separately or simultaneously with said statin treatment.

13. The antibody or antibody fragment of any one of statements 7-9, wherein said biological sample comprises serum, blood, faeces, tissue, a cell, urine and/or saliva of said human.

14. The antibody or antibody fragment of any preceding statement, wherein said human is indicated as heterozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising said mutation I474V or E670G, optionally, wherein said human is further indicated as comprising the nucleotide sequence of SEQ ID NO: 28, or said human is indicated as homozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising said mutation I474Vor E670G in SEQ ID NO: 1.

15. The antibody or antibody fragment of any preceding statement, wherein said human has been diagnosed with at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication mediated by PCSK9 and high blood pressure.

16. The antibody or antibody fragment of any preceding statement, wherein said antibody or antibody fragment is for treating or reducing the risk in said human of at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication mediated by PCSK9 and high blood pressure.

17. The antibody or antibody fragment of any preceding statement, wherein the nucleotide sequence is SEQ ID NO: 29 or 30.

18. The antibody or antibody fragment of any preceding statement, wherein said antibody or antibody fragment is for administration by intravenous or subcutaneous administration and/or is comprised in an injectable preparation.

19. The antibody or antibody fragment of any preceding statement, wherein the antibody is a human antibody.

Claims

1. An antibody or antibody fragment for use in a method of reducing cholesterol level or maintaining previously reduced cholesterol level in a human, wherein the antibody is evolocumab and said human comprises (i) an IGHG2*01 human heavy chain constant region gene segment and (ii) a nucleotide sequence encoding proprotein convertase subtilisin/kexin type 9 (PCSK9) that comprises a C-terminal domain comprising a mutation I474V in SEQ ID NO:1.

2. The antibody or antibody fragment for use according to claim 1, the method comprising, before administration of said antibody or fragment, selecting a human comprising said nucleotide sequence of (ii), wherein the human is the human of claim 1.

3. The antibody or antibody fragment for use according to claim 1 or claim 2, wherein the human has been determined to comprise the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V in SEQ ID NO:1 and/or a PCSK9 variant protein encoded by the nucleotide sequence of SEQ ID NO: 30.

4. The antibody or antibody fragment for use according to any one of claims 1-3, the method comprising the step of determining that the human comprises the nucleotide sequence that encodes a PCSK9 comprising a C-terminal domain comprising said mutation I474V and/or a PCSK9 variant protein comprising mutation I474V, optionally, wherein the determining step is performed before administration of the antibody to the human.

5. The antibody or antibody fragment for use according to claim 4, wherein the step of determining comprises assaying a biological sample from the human for a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V in SEQ ID NO: 1.

6. The antibody or antibody fragment for use according to claim 5, wherein the assaying comprises contacting the biological sample with

a. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides that can specifically hybridize to and identify in the biological sample a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V in SEQ ID NO: 1 or that specifically hybridizes to an antisense of said sequence, wherein said nucleic acid hybridizes to at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 or hybridizes to an antisense sequence thereby forming a complex when at least one nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V in SEQ ID NO: 1 is present; and/or
b. at least one oligonucleotide probe comprising a sequence of at least 10 contiguous nucleotides of a nucleotide sequence encoding the PCSK9 that comprises the C-terminal domain comprising the mutation I474V in SEQ ID NO: 1 or comprising an antisense sequence of said contiguous nucleotides, wherein said sequence of contiguous nucleotides comprises at least one nucleotide present in said selected sequence which is not present in SEQ ID NO: 28 thereby forming a complex when the nucleotide sequence encoding the PCSK9 that comprises a C-terminal domain comprising the mutation I474V in SEQ ID NO: 1 is present; and

detecting the presence or absence of the complex, wherein detecting the presence of the complex determines that the human comprises the PCSK9 that comprises the C-terminal domain comprising the mutation I474V in SEQ ID NO: 1.

7. The antibody or antibody fragment for use according to claim 5, wherein the assaying comprises nucleic acid amplification and optionally one or more methods selected from sequencing, next generation sequencing, nucleic acid hybridization, and allele-specific amplification and/or wherein the assaying is performed in a multiplex format.

8. The antibody or antibody fragment for use according to any one of claims 1-7, wherein said human is or has been further determined to be substantially resistant to statin treatment.

9. The antibody or antibody fragment for use according to any one of claims 1-8, wherein said human is receiving or has received statin treatment or has reduced responsiveness to statin treatment.

10. The antibody or antibody fragment for use according to claim 8 or 9, wherein said antibody or antibody fragment is for administration to the human separately or simultaneously with said statin treatment.

11. The antibody or antibody fragment for use according to any one of claims 5-7, wherein said biological sample comprises serum, blood, faeces, tissue, a cell, urine and/or saliva of said human.

12. The antibody or antibody fragment for use according to any one of claims 1-11, wherein said human is indicated as heterozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising said mutation I474V, optionally, wherein said human is further indicated as comprising the nucleotide sequence of SEQ ID NO: 28, or said human is indicated as homozygous for a nucleotide sequence encoding the PCSK9 C-terminal domain comprising said mutation I474V in SEQ ID NO:1.

13. The antibody or antibody fragment for use according to any one of claims 1-12, wherein said human has been diagnosed with at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication mediated by PCSK9 and high blood pressure.

14. The antibody or antibody fragment for use according to any one of claims 1-13, wherein said antibody or antibody fragment is for treating or reducing the risk in said human of at least one condition selected from a lipid disorder, hyperlipoproteinemia, hyperlipidemia, dyslipidemia, hypercholesterolemia, a heart attack, a stroke, coronary heart disease, atherosclerosis, peripheral vascular disease, claudication mediated by PCSK9 and high blood pressure.

15. The antibody or antibody fragment for use according to any one of claims 1-14, wherein:

(a) the nucleotide sequence encoding the PCSK9 is SEQ ID NO: 30; and/or
(b) said antibody or antibody fragment is for administration by intravenous or subcutaneous administration and/or is comprised in an injectable preparation.

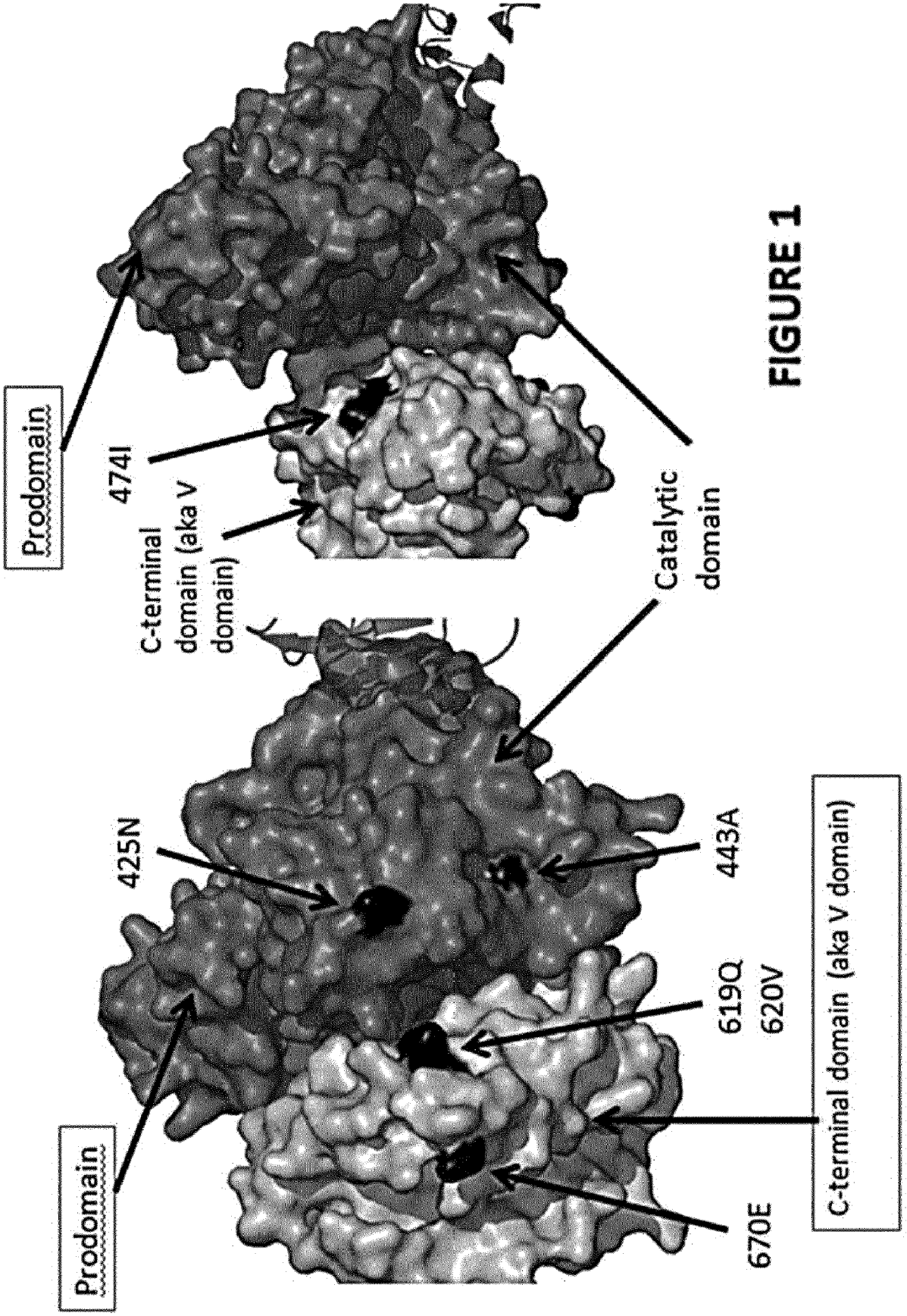
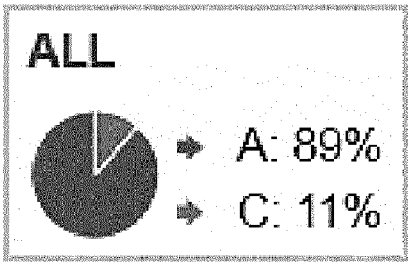
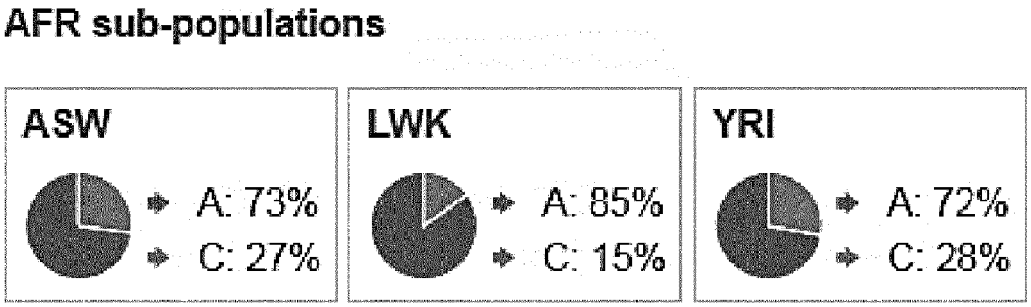
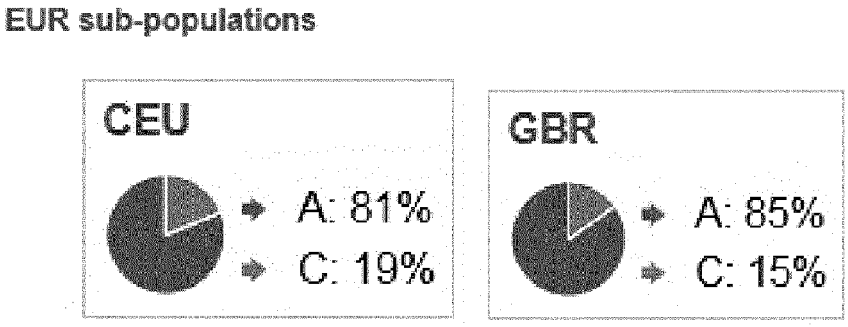

Prodomain
474I
C-terminal domain (aka V domain)
Catalytic domain
425N
443A
619Q
620V
670E
C-terminal domain (aka V domain)
Prodomain

FIGURE 1





Variants: f, c, m, e, h, p, q f, c, m, e, h f, c, m, e, h



Variants: f, c, p, aj f, c, p

Figure 2

Figure 3

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
		E	V	Q	L	L	E	S	G	G		G	L	V	Q	P	G	G	S	L	R
M99660	IGHV3-23*01 F V3-23	gag	gtg	cag	ctg	ttg	gag	tct	ggg	gga	...	ggc	ttg	gta	cag	cct	ggg	ggg	tcc	ctg	aga
AB019439	IGHV3-23*01 F	---	---	---	---	---	---	---	---	---	...	---	---	---	---	---	---	---	---	---	---
M83136	IGHV3-23*01 F VH26	---	---	---	---	---	---	---	---	---	...	---	---	---	---	---	---	---	---	---	---
Z12347	IGHV3-23*01 F DP-47	---	---	---	---	---	---	---	---	---	...	---	---	---	---	---	---	---	---	---	---
M57940	IGHV3-23*01 F V-B19.7	---	---	---	---	---	---	---	---	---	...	---	---	---	---	---	---	---	---	---	---
U29482	IGHV3-23*01 F VH26-5.0	---	---	---	---	---	---	---	---	---	...	---	---	---	---	---	---	---	---	---	---
M35415	IGHV3-23*02 F VH26	---	---	---	---	---	---	---	---	---	...	---	---	---	---	---	---	---	---	---	---
U29481	IGHV3-23*03 F VH26-3.7	---	---	---	---	---	---	---	---	---	...	---	---	---	---	---	---	---	---	---	---
AM940223	IGHV3-23*03 F	---	---	---	---	---	---	---	---	---	...	---	---	---	---	---	---	---	---	---	---
						V															
AJ879486	IGHV3-23*04 F VH3-23	---	---	---	---	g--	---	---	---	---	...	---	---	---	---	---	---	---	---	---	---
AY757302	IGHV3-23*05 F	---	---	---	---	---	---	---	---	---	...	---	---	---	---	---	---	---	---	---	---

Figure 3 (cont.)

																							CDR1-IMGT
				21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
				L	S	C	A	A	S	G	F	T	F					S	S	Y	A	M	S
M99660	IGHV3-23*01	F	V3-23	ctc	tcc	tgt	gca	gcc	tct	gga	ttc	acc	ttt	...	...	...	...	agc	agc	tat	gcc	atg	agc
AB019439	IGHV3-23*01	F		---	---	---	---	---	---	---	---	---	---	...	...	...	...	---	---	---	---	---	---
M83136	IGHV3-23*01	F	VH26	---	---	---	---	---	---	---	---	---	---	...	...	...	...	---	---	---	---	---	---
Z12347	IGHV3-23*01	F	DP-47	---	---	---	---	---	---	---	---	---	---	...	...	...	...	---	---	---	---	---	---
M57940	IGHV3-23*01	F	V-B19.7	---	---	---	---	---	---	---	---	---	---	...	...	...	...	---	---	---	---	---	---
U29482	IGHV3-23*01	F	VH26-5.0	---	---	---	---	---	---	---	---	---	---	...	...	...	...	---	---	---	---	---	---
M35415	IGHV3-23*02	F	VH26	---	---	---	---	---	---	---	---	---	---	...	...	...	...	---	---	---	---	---	---
U29481	IGHV3-23*03	F	VH26-3.7	---	---	---	---	---	---	---	---	---	---	...	...	...	...	---	---	---	---	---	---
AM940223	IGHV3-23*03	F		---	---	---	---	---	---	---	---	---	---	...	...	...	...	---	---	---	---	---	---
AJ879486	IGHV3-23*04	F	VH3-23	---	---	---	---	---	---	---	---	---	---	...	...	...	...	---	---	---	---	---	---
AY757302	IGHV3-23*05	F		---	---	---	---	---	---	---	---	---	---	...	...	...	...	---	---	---	---	---	---

```
                                                                                CDR2-
                                    41  42  43  44  45  46  47  48  49  50  51  52  53  54  55  56  57  58  59  60
                                    W   V   R   Q   A   P   G   K   G   L   E   W   V   S   A   I   S   G   S
M99660   IGHV3-23*01 F V3-23        tgg gtc cgc cag gct cca ggg aag ggg ctg gag tgg gtc tca gct att agt ggt agt ...

AB019439 IGHV3-23*01 F              --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- ...

M83136   IGHV3-23*01 F VH26         --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- ...

Z12347   IGHV3-23*01 F DP-47        --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- ...

M57940   IGHV3-23*01 F V-B19.7      --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- ...

U29482   IGHV3-23*01 F VH26-5.0     --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- ...

M35415   IGHV3-23*02 F VH26         --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- ...
                                                                                        V       Y   S   G
U29481   IGHV3-23*03 F VH26-3.7     --- --- --- --- --- --- --- --- --- --- --- --- --- --- -t- --- ta- a-c g-- ...
                                                                                        V       Y   S   G
AM940223 IGHV3-23*03 F              --- --- --- --- --- --- --- --- --- --- --- --- --- --- -t- --- ta- a-c g-- ...

AJ879486 IGHV3-23*04 F VH3-23       --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- ...
                                                                                                Y   S
AY757302 IGHV3-23*05 F              --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- ta- a-c --- ...
```

Figure 3 (cont.)

Figure 3 (cont.)

```
                                IMGT____________

                                61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80
                                   G  G  S  T  Y  Y  A  D  S  V  K     G  R  F  T  I  S  R
M99660   IGHV3-23*01 F V3-23    ... ggt ggt agc aca tac tac gca gac tcc gtg aag ... ggc cgg ttc acc atc tcc aga

AB019439 IGHV3-23*01 F          ... --- --- --- --- --- --- --- --- --- --- --- ... --- --- --- --- --- --- ---

M83136   IGHV3-23*01 F VH26     ... --- --- --- --- --- --- --- --- --- --- --- ... --- --- --- --- --- --- ---

Z12347   IGHV3-23*01 F DP-47    ... --- --- --- --- --- --- --- --- --- --- --- ... --- --- --- --- --- --- ---

M57940   IGHV3-23*01 F V-B19.7  ... --- --- --- --- --- --- --- --- --- --- --- ... --- --- --- --- --- --- ---

U29482   IGHV3-23*01 F VH26-5.0 ... --- --- --- --- --- --- --- --- --- --- --- ... --- --- --- --- --- --- ---
                                                            G
M35415   IGHV3-23*02 F VH26     ... --- --- --- --- --- --- -g- --- --- --- --- ... --- --- --- --- --- --a ---
                                        S
U29481   IGHV3-23*03 F VH26-3.7 ... --- a-- --- --- --- --t --- --- --- --- --- ... --- --- --- --- --- --- ---
                                        S
AM940223 IGHV3-23*03 F          ... --- a-- --- --- --- --t --- --- --- --- --- ... --- --- --- --- --- --- ---

AJ879486 IGHV3-23*04 F VH3-23   ... --- --- --- --- --- --- --- --- --- --- --- ... --- --- --- --- --- --- ---
                                        S
AY757302 IGHV3-23*05 F          ... --- a-- --- --- --- --t --- --- --- --- --- ... --- --- --- --- --- --- ---
```

		81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
		D	N	S	K	N	T	L	Y	L	Q	M	N	S	L	R	A	E	D	T	A
M99660	IGHV3-23*01 F V3-23	gac	aat	tcc	aag	aac	acg	ctg	tat	ctg	caa	atg	aac	agc	ctg	aga	gcc	gag	gac	acg	gcc
AB019439	IGHV3-23*01 F	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
M83136	IGHV3-23*01 F VH26	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Z12347	IGHV3-23*01 F DP-47	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
M57940	IGHV3-23*01 F V-B19.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
U29482	IGHV3-23*01 F VH26-5.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
M35415	IGHV3-23*02 F VH26	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
U29481	IGHV3-23*03 F VH26-3.7	--t	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
AM940223	IGHV3-23*03 F	--t	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
AJ879486	IGHV3-23*04 F VH3-23	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
AY757302	IGHV3-23*05 F	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Figure 3 (cont.)

Figure 3 (cont.)

				_CDR3-IMGT__						
				101	102	103	104	105	106	
				V	Y	Y	C	A	K	
M99660	IGHV3-23*01	F	V3-23	gta	tat	tac	tgt	gcg	aaa	ga
AB019439	IGHV3-23*01	F		---	---	---	---	---	---	--
M83136	IGHV3-23*01	F	VH26	---	---	---	---	---	---	--
Z12347	IGHV3-23*01	F	DP-47	---	---	---	---	---	---	
M57940	IGHV3-23*01	F	V-B19.7	---	---	---	---	---	---	
U29482	IGHV3-23*01	F	VH26-5.0	---	---	---	---	---	---	
M35415	IGHV3-23*02	F	VH26	---	---	---	---	---	---	--
U29481	IGHV3-23*03	F	VH26-3.7	---	---	---	---	---	---	
AM940223	IGHV3-23*03	F		---	---	---	---	---	---	--
AJ879486	IGHV3-23*04	F	VH3-23	---	---	---	---	---	---	--
AY757302	IGHV3-23*05	F		---	---	---	---	---	---	

VH3-23*04

Non-Synonymous FW1 residue change to Valine due to rs56069819 SNP is underlined)

E V Q L **V** E S G G G L V Q P G G S L R
L S C A A S G F T F S S Y A M S W V R
Q A P G K G L E W V S A I S G S G G S
T Y Y A D S V K G R F T I S R D N S K
N T L Y L Q M N S L R A E D T A V Y Y
C A K

VH3-23*04

(rs56069819 SNP is underlined)

gag gtg cag ctg **g**tg gag tct ggg gga ggc ttg gta cag cct ggg
ggg tcc ctg aga ctc tcc tgt gca gcc tct gga ttc acc ttt agc agc tat
gcc atg agc tgg gtc cgc cag gct cca ggg aag ggg ctg gag tgg
gtc tca gct att agt ggt agt ggt ggt agc aca tac tac gca gac tcc
gtg aag ggc cgg ttc acc atc tcc aga gac aat tcc aag aac acg ctg
tat ctg caa atg aac agc ctg aga gcc gag gac acg gcc gta tat tac
tgt gcg aaa ga

FW1 Encoded by VH3-23*04

E V Q L V E S G G G L V Q P G G S L R L S C A A S

Figure 4

REFERENCES CITED IN THE DESCRIPTION

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